THE UNIVERSITY OF COLORADO STUDIES

VOL. IV

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

December, 1906, to June, 1907

CONTENTS OF VOL. IV

No. 1

No. 2

No. 3

No. 4

ALPHABETICAL INDEX TO VOLUME IV

Volume IV Number 1

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CONTENTS

THE EPIGRAM AND ITS GREATEST MASTER, MARTIAL[1]

By Fred B. R. Hellems

When discussing this topic some years ago in one of our larger universities I found a rather puzzled uncertainty among my students about the range of the word "epigram." As they looked in half-derisive pity upon the significantly receding bay in my once less scanty hair, they agreed unhesitatingly to accept as an epigram Walter Savage Landor's playful plaint against a trick of Time:

The burden of an ancient rhyme
Is "By the forelock seize on Time!"
Time in some corner heard it said;
Pricking his ears away he fled;
And seeing me upon the road
A hearty curse on me bestowed.
"What if I do the same by thee?
How would'st thou like it?" thundered he,
And without answer, thereupon,
Seizing my forelock, it was gone.

They welcomed likewise Porson's caustic comment written when the flow of learning among the divinity men of the English universities was as low as the flood of good old port was high:

Here lies a Doctor of Divinity,
He was fellow too of Trinity.
He knew as much about Divinity
As other fellows do of Trinity.

There was some little doubt, however, when I proposed William Watson's glorious protest against the myopic and arrogant vision that sees no ultimate riddle of the universe.

Think not thy wisdom can illume away
The ancient tanglement of night and day.
Enough to acknowledge both and both revere;
They see not clearliest who see all things clear.

[1] (Reprinted from *Poet Lore*, Vol. XVI, No. 4, pp. 67–77, by permission of the publisher.)

But, of course, this last is quite as truly an epigram as Landor's lament or Porson's epitaph, and is happily covered by Klopstock's admirable definition in verse:

> Bald ist das Epigramm ein Pfeil,
> Trifft mit der Spitze;
> Ist bald ein Schwert,
> Trifft mit der Schärfe.
> Ist manchmal auch—die Griechen liebten's so—
> Ein klein Gemäld! ein Strahl gesandt,
> Zum Brennen nicht, nur zum Erleuchten.

[By times the epigram is an arrow, wounding with its point; by times 'tis a sword, wounding with its keen edge. Ofttimes, too,—in this guise the Greeks loved it,—'tis a miniature, a beam sent, not to burn, only to lighten and brighten.]

With the etymology of the word "epigram" before our minds, we need not state formally either the land of its birth or its original application. When the Greek cut an inscription on a tomb, a tripod, a pillar, or any other enduring object, he termed what he had written simply an *epigramma.*

If we recall the priority of verse to prose as the channel of artistic or even formal expression, we shall expect to find such an inscription falling into metrical form, and Herodotus, first and best beloved of all the tribe of reporters, has transcribed from some temple tripods a couple of hexametrical inscriptions which were confidingly reported to be as old as the days of Laïus, father of Oedipous.

In the beginning the exigencies of space would compel brevity, often limiting the inscription to a single line or a couplet, and in Greece even the later epigram is seldom found running beyond a modest length, although at Rome it often loses this primitive merit. Furthermore, the form and style of the epigram are intimately connected with this compulsory brevity. If the writer has only a line or two in which to express grief for a son's untimely death, to laud a high-souled hero, or to honor a notable deed, he does not trifle away his space, but with all his power strives for conciseness and finish; and these qualities remain characteristic of the epigram long after its original bounds as to subject have been overpassed and forgotten.

The subject of the earlier epigram is naturally associated closely with the object on which it appeared. A tomb might be inscribed with a father's brief but bitter plaint that he had laid therein his darling son, his life's high hope. A pillar might be eloquent with words in which the poet glorified the transcendent fidelity of those who died battling for the fatherland. "These men, having set a crown of imperishable glory upon their own land, were folded in the dark cloud of death; yet being dead they have not died, since from on high their excellence raises them gloriously out of the house of Hades."[1] On the base of a statue of Niobe by Praxiteles an enthusiastic admirer might inscribe: "From life the gods turned me into stone, and from stone Praxiteles wrought me back again to life." On a rock beside a spring some tuneful wayfarer in dusty Attica might cut this dainty invitation:

Stranger, by this worn rock thy limbs repose;
Soft through the verdant leaves the light wind blows;
Here drink from the clear spring at noonday heat,
Such rest to way-worn travelers is sweet.

But these examples have carried us to the point where the epigram is no longer of necessity an inscription, but is still a poem that might have been inscribed, and thenceforward we find the epigram treating any theme that can be compassed in a few lines. Strato may hymn in unsurpassed lyric verse the love that dies not and the beauty that age may alter but cannot lessen:

O how I loved when like the glorious sun
  Firing the Orient with a blaze of light,
The beauty every lesser star outshone!
  Now o'er that beauty steals the approach of night.
Yet, yet, I love! Tho' in the western sea
Half sunk, the day star still is fair to me.

Even greater than the beauty unquenched by age is the beauty that is undimmed by death:

Thou wert the morning star among the living,
  Ere thy fair light had fled,
Now, having died, thou art as Hesperus, giving
  New splendor to the dead.[2]

[1] The rendering is by Mackail, one of our best translators; but it fails to convey the effective beauty of the original.

[2] Despite my unbounded love for Shelley, I can but feel that this rendering by him falls short of the Greek. Merivale has been more successful, but with the easier preceding epigram.

Occasionally, however, even under kindly Athena's sky the epigram takes on a radically different tone. An ill-starred bachelor will have this appealing epitaph, which surely represents the quintessence of pessimism, well preserved in Cowper's translation:

> At three-score winters' end I died,
> A cheerless being, sole and sad.
> The nuptial knot I never tied,
> And wish my father never had.

Another misogamist snarls that the man who seeks second nuptials is a foolish sailor, who after having been shipwrecked once sails again a treacherous gulf. Or a waggish detractor pierces a physician with this shaft:

> Pheido nor hand nor touch to me applied;
> Fevered I thought but of his name and died.

But on the whole the snarl and the bitter shaft are rare. The Greek epigram is more often lyric, idyllic, or epideictic rather than epigrammatic according to the Roman and modern conception, so that Herder's exquisite quatrain marks out a real line of divergence. The Greek epigram speaks:

> Dir [Martial] ist das Epigram die kleine geschäftige Biene
> Die auf Blumen umher flieget und sauset und sticht;
> Mir ist das Epigram die kleine knospende Rose
> Die aus Dornengebusch Nektarerfrischungen haucht.

[For you the epigram is a little busy bee that flits about on the flowers, and buzzes and stings; for me it is a tiny burgeoning rose that from the bush of thorns breathes such quickening as nectar might bestow.]

In Italy every variety of epigram that had sprung up in Greece was reproduced as well as the difference in genius between the two peoples would permit. As an actual inscription it was employed by the Romans with a frequency sometimes overlooked. In literature the formal epigram appears in Ennius, the father of Latin poetry, and thenceforward never lacks representation. Quintus Lutatius Catulus, Licinius Calvus, and many others are little more than names to most readers, and it is not often recalled that the imperial hand of Augustus toyed with this form of composition. Catullus and Martial, however, are familiar to all and have come to be synonymous with epigram. In fact, the more incisive and aggressive employment of this form by these two writers, particularly by Martial, gave the word a new meaning:

> Omne epigramma sit instar apis, sit aculeus illi.
> Sint sua mella: sit et corporis exigui.
>
> The qualities rare in a bee that we meet
> In an epigram never should fail,
> The body should always be little and sweet
> And a sting should be left in the tail.
>
> —*Panorama of Wit*, 1809, p. 250.

These lines, notwithstanding the protests of accurate scholars, continue to express the ordinary understanding of epigram, and this fact is due very largely to Martial's influence. Indeed, so closely does the theory of this couplet correspond to much of Martial's practice that it was attributed to his authorship by a long-persistent error.

That Martial was the greatest of epigrammatists was stated by Lessing in his still valuable treatise on the epigram, and has been reiterated by many men of less authority. It is easy to abuse Martial; but it is impossible to procure a reversal of this general verdict. Relatively to the other great Latin authors Martial is at present little read, and for one student who is familiar with the molder of the modern epigram the readers of Horace or Vergil may be counted by scores or even hundreds. Of this neglect a talented Frenchman has offered an explanation in a delightful article in the *Revue des Deux Mondes* for July 15, 1900. "Martial is little read in France," says M. Boissier, "and the poet himself is to blame, because his works with all their wit and charm contain disgusting obscenities which render it dangerous to speak to younger people of the *jolies choses* for fear of inspiring them with a desire to read the rest." Thus the youth of Paris are guarded from the perils of the deep. Previous generations of Frenchmen, however, were not so paternally sheltered, as is shown by Martial's tremendous influence on French literature, nor have commonsense Germany and respectable England refrained from the fullest enjoyment of his genius.

Martial was born on a fourth of March between 38 and 41 of our era. His parents lived in the little town of Bilbilis in central Spain and gave their son an excellent education, which was probably begun in his native town and continued in some neighboring city. This education would not differ in any essentials from that of a boy trained at Rome, for Spain had devoted herself enthusiastically to the same culture as that of the imperial city, and was already sending thither successful teachers. At this period Rome had the same attraction for a youth "suffering from literary aspirations" that Paris or London or New York has so often exercised on his modern counterpart; and this attraction would be all the stronger for Martial by reason of the number of influential Spanish houses already established at the capitol. To Rome, then, he went as a sanguine youth in 64 A. D., and in most respects became more of a city man than his contemporaries who first saw the light in the Bowery of Rome, the *fervens Subura.* Of the earlier years spent there we know little. He doubtless prepared for work as an advocate, and very probably wrote poems, some of which may have been revamped for publication after he acquired vogue. In the year 80 A. D., however, when the great Flavian amphitheater, now known as the Colosseum, was dedicated with spectacles on a stupendous scale, he came into prominence with some suitable epigrams; and from this year on we can gather many details of his round of life. For a time he lived in rented quarters which learned commentators have felt justified in describing as "poor and humble," because the poet playfully states that they are "three flights back." But during the last four or five years of his sojourn in the metropolis he was the respectable proprietor of his own dwelling. He owned a little estate at Nomentum which he wittily derides in pleasantries that must not be taken as legal evidence. He was always importuning his friends for money or goods, and was always impecunious, probably as a result of generous Bohemian expenditure rather than of an oppressively meager income. At any rate, he managed to live the life of a fashionable man of letters, thoroughly after the manner sung of in Goethe's "Genialisch Treiben."

Bald ist es Ernst, bald ist es Spass.
Bald ist es Lieb, bald ist es Hass.
Bald ist es dies, bald ist es das.
Es ist ein Nichts, und ist ein Was.

[Now it is earnest, now it is jest. Now it is love and now it is hate. Now it is this, and now it is that. It is a nothing and it is a something.]

He made friends and enemies, won sweet favor and bitter envy; he walked and talked, dissipated deeply and slept lightly; he frequented theater and bath, library and club; he ran to the country when tired of the town, and returned to the town when tired of the country; he dined much and dreamed a little; he observed some of the virtues of his fellow-men and women, and all of their vices; he wrote good poems and bad; and achieved fame and unhappiness. Then after thirty-four years the quiet rural life he had deserted took its revenge, as it so often does on its successful but embittered children, and brought him back to the peaceful scenes of his native province. A generous patroness provided him with an estate that both delighted the mind and supported the body, and here he seems to have been fairly happy save for the rasping gossip of the tiny village and his inevitable longing for the delights of the capital. It was amid the old scenes that he passed away, lacking about ten years of the three score and five which he had prayed the grim sisters three might spin for him.

Martial's popularity was immediate and general. He was read much, not only at Rome, but also in the remote parts of Rome's dominions for many centuries. Even during the Middle Ages he did not fall into such neglect as was the lot of many Latin writers, and with the "Renaissance" he came rapidly into his own, or even more than his own.

Of the reasons for Martial's triumph it is always easy to write at length; but they generally come back to the fact that he has put before us the frailties of human nature in unforgettable verses. You cannot forget Martial any more than you can escape human nature with its mingled yarn of good and ill together. "My page is life," he asserts; and his claim is largely true, although it is not all of life. This is unquestionably the reason that his pages are ever fresh, and that his jests make newer jests seem old. Years ago Mark Twain was credited with a *mot* that the younger generation seems to have forgotten. "There are but thirteen jokes in the world," he said, "and Aristophanes and Martial had twelve of them. Modesty prevents me from mentioning the author of the thirteenth." The commonplace that there is no new joke is true in foundation; for the modern joke is simply its ancient forerunner adapting itself to a new environment.

From Martial's pages we may evoke all the old familiar faces of jest and epigram with no magician's wand to aid us:

> The golden hair that Galla wears
>   Is hers. Who would have thought it?
> She swears 'tis hers and true she swears,
>   For I know where she bought it.

'Twas that mellowest of epigrammatists, Sir John Harrington, that gave Galla her English dress; but Martial had presented her in Latin. And here I must break my paragraph to apologize to the spirit of old Sir John for all the countless throng who have forgotten or never learned that he was the author of that peerless flower of English epigrams:

> Treason doth never prosper. What's the reason?
>   For if it prospers none dare call it treason.

In Galla's train come all the women who have sought to remedy the unkindness of nature by the ingenuity of man, and they have been many. "Thais has black teeth, Læcania white; the former has her own, the latter wears purchased ones." These two ladies have appeared often enough in English garb, but even more often in French:

> Rien de plus noir que les dents d'Alizon,
>   Rien de plus blanc que les dents de Fanchette.
> Devinez-vous quelle en est la raison?
>   L'une a ses dents, et l'autre les achète.

Such is the adaptation by M. de Morvilliers; but more than a score of others in French are known to me, and there are doubtless as many others that I have missed. A purchaser of ivory teeth and false hair in the world of letters is the plagiarist who wishes to be thought a poet by the aid of Martial's verses. "In the same way in which you are a poet you may have tresses when you are bald." This summons before us the man of "shining hairless pate" at whom Martial wings many merciless jests which do not seem nearly so laughable to me now. Straight back to Homer and the Old Testament can we trace this mocking at the footprints of age; but not often do the avenging bears appear. However, if Martial was often witty on a theme unwelcome to many of us, he was not less often witty on a theme over which his heart was not always light, for his eyes were ever toward the lender of money, and his purse was generally filled only with cobwebs.

> Lend Sponge a guinea! Ned, you'd best refuse
> And give him half. Sure that's enough to lose.

But now the faces no longer wait to be summoned, they are fairly streaming past us. The aged dame wedded for her attractive combination of accumulated wealth and wasting cough; the well-matched couple who ought to agree better because they are so thoroughly alike, "each as bad as bad can be;" the shopper who handles all the richest wares from the highest shelves and spends a farthing; the representative of the *jeunesse dorée* who does everything prettily, almost "'cutely," from tennis to astronomy; the beau who sends countless *billets-doux* and receives none; the busybody who whispers mysteriously in your ear what might be proclaimed from the housetops; the lawyer who "runs on from Magna Charta to old King John," but utters never a word about the sheep—all of these belong no more to Roman life two thousand years ago than to American life in the twentieth century.

But where shall we interrupt this line of hurrying faces? The coachman who brought a double price because he was deaf comes to claim as his descendant the canny caddy who is blind enough for two. The young Roman society man reciting his own verses after pleading the adequate excuse of a sore throat sees a congenial sister in the young society woman who sings in spite of such a cold. At some of the faces we must glance twice before they are recognized. "Who are you?" "I was the victim of many fires who always received generous contributions from kindly friends until I burned my house once too often." "And who are you now?" "I am the insurance joke, without which Life would die." "Who were you with the laughing half-offended face?" "I was Baiae, sweetest of seaside resorts, always maligned as the cause of too many flirtations." "To me," Martial said, "a lady came a Penelope and from me departed a Helen." "And who are you now?" "I am Ostend or Saratoga or any other sea-and-sun-kissed strand where a man and a woman search each other's eyes for the little winged god and remember or forget." With these our line of faces has only begun; the others are just as familiar, but we must let them flit by unnoted.

Another phase of interest attaching to Martial is his constant reappearance in unforeseen places. In Herrick or Ben Jonson or countless kindred spirits we should naturally look for many traces of Martial, and should find them in even greater abundance than we had looked for; but Martial is not bounded by the expected. For instance, from the tongues of all of us there runs lightly off:

> I do not love you, Dr. Fell;
> The reason why I cannot tell.
> But this I'm sure I know full well,
> I do not love you, Dr. Fell.

We do not remember, however, that the original is Martial's, "I do not love you, Sabidius, nor can I say why; I can only say this, I do not love you." Indeed, the story goes that the immortal Dr. Fell, bishop of Oxford in the latter half of the seventeenth century, was interviewing one Tom Brown about a threatened rustication and was seeking any possible excuse for being merciful. Finally the bishop said to the young scapegrace that if he could even translate this epigram of Martial's the authorities would have some grounds for not rusticating him, whereupon the youth, imperiled but undismayed, produced the rendering that will flit forever on the lips of men. Most of us recall Leigh Hunt's "Wise and Wiser," although we are culpably neglecting the author of "An Angel in the House" and "Jenny Kissed Me."

> Abel fain would marry Mabel,
> Well it's very wise of Abel.
> But Mabel won't at all have Abel;
> Well it's wiser still of Mabel.

To a few of us there comes back the superscription: "From the French of Tabourot;" but Tabourot was only one of scores who have drawn from our unfailing spring. "Paula, you wish to marry Priscus; I do not wonder; you are wise. Priscus does not wish to marry you; Priscus too is wise." If Martial presents himself so persistently in printed pages, he is also stumbled upon in less likely places. When visiting Ravenna, that "living dream of a city dead," some years ago I found excellent wine included gratis with an excellent dinner, but I was charged extra for water which had to be brought over the hills from Faenza. The circumstance kept haunting me until from the inner cells of my memory I drew forth Martial's experience in the city where wine was so plentiful that a cistern was more valuable than a spreading vineyard. "A villainous innkeeper at Ravenna cheated me the other day; I asked for wine mixed with water and the rascal sold me pure wine."

Herewith I have repeated the sin of most readers of Martial, for I have been lured to tarry so long over his more playful song that I must slight his more serious strains.

There is a Catullus-echoing, Horace-recalling Martial, who can sing of friendship and a calm, settled, sweet content in verse not unworthy of his Augustan masters; a Martial who has caught a vision of the *aurea mediocritas* in life's falsehoods of extremes and can picture forth this golden mean for his fellow-men. Where shall we find surpassed his description of the legitimate reward of a well-spent life, familiar to English readers in the adaptation of Pope?

At length my friend (while time with still career
Wafts on his gentle wing this eightieth year)
Sees his past days safe out of Fortune's pow'r,
Nor dreads approaching Fate's uncertain hour;
Reviews his life, and in the strict survey,
Finds not one moment he could wish away,
Pleas'd with the series of each happy day.
Such, such a man extends his life's short space,
And from the goal again renews the race;
For he lives twice who can at once employ
The present well, and e'en the past enjoy.

Many poets have warned us against tomorrow, bidding us gather rosebuds while we may, and Martial is of the band; but one of his odes suggests by the faintest undertone that today is a rather solemn little flower withal. This undertone, it seems to me, has never been so daintily reproduced as in the rendering by Goldwin Smith:

Friend of my heart—and none of all the band
  Has to that name older or better right:
Julius, thy sixtieth winter is at hand;
  Far spent is now life's day, and near the night.
Delay not what thou would'st recall too late;
  That which is past, that only call thy own:
Cares without end and tribulations wait,
  Joy tarrieth not, but scarcely come is flown.
Then grasp it quickly, firmly to thy heart—
  Though firmly grasped, too oft it slips away:—
To talk of living is not wisdom's part:
  Tomorrow is too late: live thou today!

Still more unlike the Martial of popular conception does he appear in an epitaph on a little slave-girl, whose shade he commends to the loving care of the shades of his father and mother. Even the little maiden's name is a caress:

> Ye parents, Fronto and Flocilla here,
> To you I do commend my girl, my dear,
> Lest pale Erotion tremble at the shades,
> And the foul dog of hell's prodigious heads.
> Her age fulfilling just six winters was,
> Had she but known so many days to pass.
> 'Mongst you, old patrons, may she sport and play
> And with her lisping tongue my name oft say.
> May the smooth turf her soft bones hide, and be,
> O earth, as light to her as she to thee! (*Fletcher.*)

Perhaps these three quotations will have given us a glimpse of the anti-Martial in our epigrammatist; at any rate, they may serve to bid us remember that in the poet's complex being salt and spleen, the old *sal* and *fel*, are ofttimes united with serious thought and kindliness of heart. And if we take leave of him by Erotion's grave, we may judge more generously the nature and character of a man whose writings afford only too painful grounds for a judgment that must still be severe, even when justice has been tempered by mercy.

It has been said most happily that the epigram is to literature what the engraved gem is to plastic art. From the Greek hand it issued more dainty, more direct, more simple and sweetly winning; from Martial we receive it sometimes in delicate form, often crisp and vigorous, even at times repulsive, but ever with its lines clear and strong, the work of a master-craftsman. His more delicate epigrams, however, were not the work that won him fame, and they are left too often for the praise of the scholar who clings to beautiful Greek ideals, whereas his scintillating humor and biting wit have been enjoyed by many tastes in all ages since the Roman Empire. Whether the course of the epigram is followed in Italy, France, Germany, or England, the influence of Martial is encountered at every turn. For good or for ill, he molded the epigram, and those who came after him wrought as he had taught them.

A NEW MASTER OF ENGLISH PROSE AND SOME THEORIES OF VALUE[1]

BY FRED B. R. HELLEMS

In entering upon a consideration of the work of a new English writer, Mr. G. Lowes Dickinson, may we unmask ourselves at once with the frank avowal that we regard him as one of the greatest living masters of English prose, and his views of life as representing the most enlightened and reassuring ideals of a groping and troubled age? If his books are not destined to outlast the pyramids, he will at any rate escape Libitina for many generations, and our literature is appreciably richer for his contributions. Moreover, it is safe to predict that Mr. Dickinson will come into his own not altogether slowly; for, despite the baneful sweep of utilitarianism, we do respond in some measure to the call of the ideal and the beautiful; despite disheartening and deadly failures, we feel that, even in our daily round, "life it is that conquers and death it is that dies." If this is true, our Cambridge essayist may expect from his age a favorable verdict not long deferred; for in his pages the cause of Life and Hope and Beauty is pleaded with the convincing power of an able mind and the winning charm of an almost perfect style.

Before speaking as an advocate, however, he has examined as a judge; and his plea for the things which are better appears as a natural result of an investigation at once reasonable, penetrating, and sympathetic, into the world about him and the various standards of life. In his *Modern Symposium*, for instance, we have as participants a Tory, a Liberal, a conservative, a socialist, an anarchist, a professor, a man of science, a poet, a gentleman of leisure, a member of the Society of Friends, and a man of letters; and in every case the speaker puts his views so well that the most ardent advocate of the particular doctrine or theory could hardly desire a more attractive exposition thereof. To take an extreme case of this clairvoyant sympathy with the views of others, let us write down part of a speech from the lips of Angus MacCarthy, the anarchist:

[1] Reprinted from *The Dial*, Vol. XLI, pp. 226–30 (October 16, 1906), with permission of the editor.

"Oh!" he broke out, "if I could but get you to see that this whole order under which you live is artificial and unnecessary! But we are befogged by the systems we impose upon our imagination and call science. We have been taught to regard history as a necessary process, until we come to think it must also be a good one; that all that has ever happened ought to have happened just so and no otherwise. And thus we justify everything past and present, however palpably in contradiction with our own intuitions. But these are mere figments of the brain. History, for the most part, believe me, is one gigantic error and crime. It ought to have been other than it was; and we ought to be other than we are. There is no natural and inevitable evolution towards good; no co-operating with the universe, other than by connivance at its crimes. That little house the brain builds to shelter its own weakness must be torn down if we would face the truth and pursue the good. Then we shall see amid what blinding storms of wind and rain, what darkness of elements hostile or indifferent, our road lies across the mountains towards the city of our desire. Then and then only shall we understand the spirit of revolution. That there are things so bad that they can only be burnt up by fire; that there are obstructions so immense that they can only be exploded by dynamite; that the work of destruction is a necessary preliminary to the work of creation, for it is the destruction of the prison walls wherein the spirit is confined; and that in that work the spirit itself is the only agent, unhelped by powers of nature or powers of a world beyond—that is the creed—no, I will not say the creed, that is the insight and vision by which we of the Revolution live. By that I believe we shall triumph. But whether we triumph or no, our life itself is a victory, for it is a life lived in the spirit. To shatter material bonds that we may bind the closer the bonds of the soul, to slough dead husks that we may liberate living forms, to abolish institutions that we may evoke energies, to put off the material and put on the spiritual body, that, whether we fight with the tongue or the sword, is the inspiration of our movement, that, and that only, is the true and inner meaning of anarchy."

How many of us ever dreamed of anarchy voiced in words like these? And yet MacCarthy is possibly the speaker with whom the master of the banquet (who is, of course, Mr. Dickinson *in propria persona*) has least sympathy. In our own experience, each new page left us more convinced that we were dealing with a man who had seen the whole in its parts and the parts in the whole, who had kept his feet upon solid earth while his eyes were turned to the signals from the heights, so that with each step we found ourselves more willing to follow his upward leadership. And the heights to which he leads us, or rather to which he invites us to climb by his side, are always beautiful, albeit occasionally dimly descried by myopic eyes or not quite to be scaled by the wayfaring man.

The greatest height, indeed, he himself never confidently achieves; for he concludes his dialogue on *The Meaning of Good*, a search for reality, with a glorious allegorical vision, and waking from it says:

> So that I have had to go on ever since with the knowledge I then acquired, that whatever Reality may ultimately be, it is in the life of the affections, with all its confused tangle of loves and hates, attractions, repulsions, and, worst of all, indifferences, it is in this intricate commerce of souls that we may come nearest to apprehending what perhaps we shall never wholly apprehend, but the quest of which alone, as I believe, gives any significance to life, and makes it a thing which a wise and brave man will be able to persuade himself it is right to endure.

Accordingly, with his great Greek master and not a few others from the kings of thought, he seems to end his climbing in a cloud; but it is a cloud lightened by hope rather than darkened by despair, and enforces the thought that "they see not clearliest who see all things clear." To other peaks, however, he leads us, where the vista is as clear as it is beautiful, and even the paths through the lower-lying valleys have their own appropriate charm.

The themes treated by Mr. Dickinson are not new, nor does the form of his treatment offer any innovation. Religion, the meaning of good, literature, art in general—in short, the things of the mind and the spirit—are treated in essay or dialogue or letter, and we do not need to be reminded that these forms were brought to artistic perfection in olden days. The fact is merely that, having chosen immortal topics, he has treated them with not less largeness of outlook than clearness of inward vision, and has exhibited unerring judgment and unfailing skill in adapting his form to his matter. Thus he is manifestly right in his feeling that a discussion of the meaning of good belongs "to the sphere of right opinion and perception, rather than to that of logic and demonstration, and seems therefore to be properly approached in the tentative spirit favored by the Dialogue form," nor can we refuse to agree that this literary form comes closest to the interchange of actual conversation, "from which we gain our best lights on such a subject." The same unerring instinct or judgment leads him to put his contrast between eastern and western ideals (*Letters from a Chinese Official*) in the form of letters from an enlightened Chinaman who has resided long in England without losing his affection for his native land and all that it represents. Howbeit, other men are writing on these same eternal subjects without failing to choose appropriate garb therefor, so that we are driven to the provocative statement that our author treats the themes with greater power than most of his contemporaries and makes the appropriate garb more beautiful. In the nature of things, it is impossible to justify such a statement by fragmentary excerpts and curtailed arguments; but we should be thoroughly surprised if many intelligent readers should rise from a perusal of Mr. Dickinson's works with any strong dissent from the judgment we have submitted.

Recognizing freely this impossibility, we must still face the duty of giving at least an adumbration of our author's position with reference to some of the central themes of life, and we may as well fail on religion as on any other subject. His attitude, then, in marred and imperfect form, is about this:

I. Religious truth is attainable, if at all, only by the method of science. There is no "revelation" in the accepted usage of the term.

II. Religion is a "reaction of the imagination upon the world as we conceive it in the light at once of truth and of the ideal," which amounts to saying that religion is a certain attitude toward life, willing to recognize the helpfulness of ideas not based on definitely ascertained truth.

III. If this definition is too wide, we should consider that there is something between hope and faith, but nearer to the latter and called by its name—an attitude of "active expectancy, the attitude of a man who, while candidly recognizing that he does not know, and faithfully pursuing or awaiting knowledge, and ready to accept it when it comes, yet centers meantime his emotional and therefore his practical life about a possibility which he selects because of its value or its desirability." In other words, for practically all men there must be a "volitional assumption," not based upon knowledge, as to the worth-whileness of existence, if life is to be most noble and most fruitful.

The objections to such a view were too manifest to escape our thinker, and he has stated them fairly, thereby relieving us from enlarging upon them; and we may merely point out that this is the faith, not of an ecclesiastic, but of a platonizing philosopher. And yet, with the more recent work of our author before him, Mr. Gilbert Chesterton could not have written his flamboyant if futile chapter on Neo-Paganism. Mr. Dickinson does not attempt "merely to revive the pagan idea of a simple and rational self-completion." Rather, he looks for the tide of noblest spiritual progress where the lustrous and rapturous river from the pagan springs of Love and Beauty and Wisdom meet the more sober stream of ideals from the fountain of Christianity. The last speaker in the *Symposium*, who "expressed himself in a style too intellectual for lovers of poetry, too metaphorical for lovers of philosophy," voices the thought in this glowing deliverance uttered in the glamor of the dawn:

> It is only in the soil of Paganism that Christianity can come to maturity. And Faith, Hope, Charity, are but seeds of themselves till they fall into the womb of Wisdom, Beauty, and Love. Olympus lies before us, the snow-capped mountain. Let us climb it, together, if you will, not some on the corpses of the rest; but climb at least, not fester and swarm on rich meadows of equality. We are not for the valley, nor for the forest or the pastures. If we be brothers, yet we are brothers in a quest, needing our foremost to lead. Aphrodite, Apollo, Athene, are before us, not behind. Majestic forms, they gleam among the snows. March, then, men in Man!

If we add this half-mystic flight to the formal statement essayed above, we shall probably draw as near to the inner sanctum as our philosopher-priest cares to allow the profane to approach without longer service; and even those who cannot accept his religion and worship in his spirit must feel their hearts quickened and their lives enlarged from visiting the courts of the temple by his side.

From his views on art and literature there will be fewer dissenters. Where can we find anything on letters more exquisite than the sentiments of our Chinese official?

> Our poets and literary men have taught their successors, for long generations, to look for good, not in wealth, not in power, not in miscellaneous activity, but in a trained, a choice, an exquisite appreciation of the most simple and universal relations of life. To feel, and in order to feel to express, or at least to understand the expression of all that is lovely in Nature, of all that is poignant and sensitive in man, is to us in itself a sufficient end. A rose in a moonlit garden, the shadow of trees on the turf, almond bloom, scent of pine, the wine cup and the guitar; these and the pathos of life and death, the long embrace, the hand stretched out in vain, the moment that glides forever away, with its freight of music and light, into the shadow and hush of the haunted past, all that we have, all that eludes us, a bird on the wing, a perfume

escaped on the gale—to all these things we are trained to respond, and the response is what we call Literature.

Hardly less effective is the treatment of art in the dialogue on *The Meaning of Good*, a treatment almost as perfect in its way as the well-known stanzas quoted from the "Ode to a Grecian Urn" in the course of the discussion, to which we can only allude. Again, in the third or central chapter of the essays on religion we may find the following thoughts on the contribution of architecture to religion:

> It has raised the material habitation of the Divine, and in doing so has reflected, I think, by a perhaps unconscious symbolism, the forms in which that Divine has been conceived. Surely, at least, one might question whether the difference between a classical temple and a Gothic church is to be attributed only to a difference of climate, or of technical skill and tradition. It would be a curiously happy chance, if it were merely chance, that made the house destined for the abode of one of the bright Olympians a palace of gleaming marble set on a hill by the sea, perfect in form, brilliant in color, a jewel to reflect the sun and the sky, a harp for the winds to play upon, an incarnation of the spirit of the open air, of the daylight and of the blue heaven; while, for the mysterious Jehovah and the God Man His Son, there rose into gray and weeping skies huge emblems of the cross, crowned with towers aspiring to a heaven unexplored, and arched over huge spaces where the eye is lost in the gloom, where form is dissolved in vagueness, and the white light of day, rejected in its purity, is permitted to pass only upon condition that it depicts in somber colors the pageant of the life of the soul. That architecture has, whether by chance or no, a symbolic value, as well as one purely and simply aesthetic, will not, I think, be disputed by those who are sensitive to such impressions; and, so regarded, architecture has been, and might be again, one of the chief expressions of religion.

One recognizes throughout the doctrine of Goethe that art rests fundamentally on a kind of religious sense, and therefore unites so readily with religion; but one recognizes also an insistence with Morris on the possibilities of an intimacy and tenderness of art that shall allow it to become more easily an integral part of our daily lives.

Foregoing the pleasure of commenting on other phases of Mr. Dickinson's works, we must content ourselves with a brief mention of his attitude to our own land. To the present reviewer he seems to be absolutely fair and candid, albeit his candor is of the unflinching sort. Far too many of his readers both in America and in England will be prone to find his final verdict in the speech of Arthur Ellis, the traveled journalist, and inasmuch as that contributor's arraignment of our "worship of acceleration" and our "doctrine of progress" is not less quotable than powerful, the reviewers and others will be sure to keep it before the public. Herein, however, we should be erring grievously; for Ellis, although the giver of the intellectual feast regards his attack as formidable, sits down amid a "hubbub of laughter, approval, and protest, confusedly mixed;" and a little later Sir John Harington, a gentleman of leisure interested mainly in art, takes up the journalist's diatribe with the expression of a strong hope that the better age for artistic interests may after all dawn in America. But from neither journalist nor artist should we accept our essayist's own views, which may be best understood from his deliberate words in the introduction to the American edition of the *Letters from a Chinese Official*:

> For it is impossible not to recognize that the destinies of Europe are closely bound up with those of this country; and that what is at stake in the development of the American Republic is nothing less than the success or failure of Western civilization. Endowed, above all the nations of the world, with intelligence, energy, and force, unhampered by the splendid ruins of a past which, however great, does but encumber, in the Old World, with fears, hesitations, and regrets, the difficult march to the promised land of the future, combining the magnificent enthusiasm of youth with the wariness of maturer years, and animated by a confidence almost religious in their own destiny, the American people are called upon, it would seem, to determine, in a pre-eminent degree, the form that is to be assumed by the society of the future. Upon them hangs the fate of the Western world.

One who did not know many sides of Cambridge would hardly be prepared to hear this voice from her academic shades; but, having heard it, one feels no serious rebellion against this other assertion about America:

> For a century past she has drawn to herself, by an irresistible attraction, the boldest, the most masterful, the most practically intelligent of the spirits of Europe; just as, by the same law, she has repelled the sensitive, the contemplative, and the devout. Unconsciously, by the mere fact of her existence, she has sifted the nations; the children of the Spirit have slipped through the iron net of her destinies, but the children of the World she has gathered into her granaries. She has thus become, in a sense peculiar and unique, the type and exemplar of the Western world. Over her unencumbered plains the Genius of Industry ranges unchallenged, naked, unashamed.

With the spirit of these words from the aged university beside the Cam, who shall quarrel? Nay, is it not the best evidence of our strides toward healthful manhood that we have no longer the childish and neuralgic sensitiveness we manifested under the searching criticism of a gifted son from the sister-university on the Isis? Such critics as Matthew Arnold and Mr. Dickinson must help us to receive "the spirit of the world that created manners, laws, religion, and art—which is hovering even now at our gates in quest of a new and more perfect incarnation." Well will it be for us, and for the world at large, if this incarnation is achieved while our nation is yet young and time itself has not grown old.

For a consideration of Mr. Dickinson's style *per se* we have little space remaining. However, the foregoing quotations have spoken for themselves, and we may limit our excerpts to one example of simple description, perhaps the most difficult form of artistically effective prose. It is introduced by the author in partial answer to the query as to what manner of men these Orientals are.

Far away in the East, under sunshine such as you never saw (for even such light as you have you stain and infect with sooty smoke), on the shore of a broad river, stands the house where I was born. It is one among thousands; but every one stands in its own garden, simply painted in white or gray, modest, cheerful, and clean. For many miles along the valley, one after the other, they lift their blue or red-tiled roof out of a sea of green; while here and there glitters out over a clump of trees the gold enamel of some tall pagoda. The river, crossed by frequent bridges and crowded with barges and junks, bears on its clear stream the traffic of thriving village-markets. For prosperous peasants people all the district, owning and tilling the fields their fathers owned and tilled before them. The soil on which they work, they may say, they and their ancestors have made. For see! almost to the summit what once were barren hills are waving green with cotton and rice, sugar, oranges, and tea. Water drawn from the river-bed girdles the slopes with silver; and falling from channel to channel in a thousand bright cascades, plashing in cisterns, chuckling in pipes, soaking and oozing in the soil, distributes freely to all alike fertility, verdure, and life. Hour after hour you may traverse, by tortuous paths, over tiny bridges, the works of the generations who have passed, the labors of their children of today; till you reach the point where man succumbs and Nature has her way, covering the highest crags with a mantle of azure and gold and rose, gardenia, clematis, azalia, growing luxuriantly wild. How often here have I sat for hours in a silence so intense that, as one of our poets has said, "you may hear the shadows of the trees rustling on the ground;" a silence broken only now and again from far below by voices of laborers calling across the water-courses, or, at evening or dawn, by the sound of gongs summoning to worship from the temples in the valley. Such silence! Such sounds!

Such perfume! Such color! The senses respond to their objects; they grow exquisite to a degree you cannot well conceive in your northern climate; and beauty pressing in from without molds the spirit and mind insensibly to harmony with herself.

To borrow from an old critic, anybody could write that except those who have tried. But with our excerpts before us we feel most keenly that they have utterly failed to convey any idea of the charm of the complete works, and we fear we should feel the same even in the presence of the better selection that any of our readers could have made.

Of the various works we have mentioned, the *Modern Symposium* seems to us the finest, although the others in their own way achieve an excellence that need not fear comparison and will doubtless be preferred by not a few readers. The scene of the masterpiece is laid on a Sussex terrace in the month of June, and the dialogue, or rather the series of monologues, lasts from the late evening light to the dawn; but the reader feels that there was never a flagging moment from the opening speech of the comfortably discouraged Tory speaking appropriately after a comfortable dinner, to the semi-oracular utterance of the poet-philosopher speaking with even greater appropriateness while the glamor of dawn passed into the clear light of morning. Every character is made to speak in the language and style one feels inevitable. Indeed, one could easily transfer the speakers from the printed page to their accustomed walks of life, and in some cases could assign a definite name. There is not a faulty word at any turn, nor the least suspicion of striving for effect. The very transitions from character to character seem to bind the parts together and disappear in their service. Seldom has art been concealed more skilfully than in these pages, where Mr. Dickinson is most himself. In many of his other writings one can put a hand on this passage or that, and murmur Goethe, Landor, Pater; but in this work one feels strongly only the great master of them all, who wrote the parent *Symposium*. And perhaps one could pay no greater tribute to the contemporary *Symposium* than to say it is not unworthy to stand beside the Platonic original. Of course, it falls far short of the older dialogue in imaginative range—which is merely saying that it does not attain the unattainable and ought not to be compared with the incomparable, for Plato's *Symposium* and *Phædrus* still occupy a niche by themselves in the hall of fame of imaginative prose. In one respect, however, the modern product is, perhaps, not inferior, for it does keep a shade more closely in touch with our human hopes and needs. From the master's banquet one rises amidst the fumes of the strong wine of almost demoniacal possession, such as Plato himself describes in his doctrine of enthusiasm, stimulating, exhilarating, sweeping us to the skies of fancy. At the disciple's feast is still strong wine; but it is the wine of helpful, aspiring reason, glorifying and uplifting, preparing us to face "without excitement or elation the duties of the new day."

It would be easy to select the writers who have influenced Mr. Dickinson most, but it must suffice to recall that his reading represents the curriculum of a Fellow of a Cambridge college with a cultured taste for literature and philosophy. We must point out, however, that the Greek classics have occupied the fundamental position in molding his style and thought, and we regard it as a thrice happy accident that we were introduced to him through his *Greek View of Life*,[1] for it is the natural portal. With modern literature he is only less familiar; and American readers will even find manifest traces of Walt Whitman. In every case, however, the traceable influence is entirely free from any suggestion of plagiarism, and we have no mere collection of jewels, but a new and finished product. Even the metrical quotations inspire the feeling that they should have been written for exactly the place they occupy. Over all of his writing is shed just enough of the *poeticus color* to make his style charming as well as effective. Indeed, for those of us who see in English prose one of the highest forms of art—all the more important because it can ultimately be made to appeal to a practically unlimited constituency—Mr. Dickinson at his best fulfils Sainte-Beuve's critical demand upon poetry—*il fait battre le cœur.*

[1] Reviewed by the present writer under the caption, "The Old Untroubled Pagan World," in *The Dia* or March 16, 1906.

SHAKESPEARE AND PSYCHOGNOSIS

ESSAY III. MAJOR CHARACTERS OF "THE TEMPEST" [*Concluded*] [1]

By Melanchthon F. Libby

Miranda: Ideal Feminine Type

Sycorax, Claribel, Ceres, and Juno, and the sea-nymphs, are female characters interesting to the student of *The Tempest*, but strictly speaking Miranda is the only female character dramatically portrayed. Of Miranda's mother almost no mention is made, though in the relation of his downfall it is remarkable that Prospero says nothing of his duchess, since the girl should naturally be curious concerning her lost parent. The austerity of Prospero is emphasized by the fact that Miranda has been twelve years upon the island without having learned anything of her origin. Her remembrance of the women that once tended her prepares her to believe in her high birth, still the tale affects her like an improbable romance. If the loss of his wife, before his child was three years old, was associated with his overthrow, it must have added to his sense of injury, but even in the fifth act there is no mention of her. The couplet

> "Thy mother was a piece of virtue, and
> She said thou wast my daughter,"

records all that we know of the mother of Miranda. Miranda appears in four scenes—the second, fifth, eighth, and ninth.

The whole burden of pity, caused by the sight of the vessel dashed to pieces, with its freight of noble creatures, as she generously and romantically conceives, is transferred to the interest of Ferdinand the moment she meets him. Pity is converted by the chemistry of romance into love of the sufferer. The immense compassion and sympathy revealed in the earliest speeches of Miranda are the natural overflow of a full and intense heart not yet engaged in a romantic attachment.

While her father tells her the story of her life, her pride of birth is roused, but much more her feelings of pity for her father and his cares. She listens with the intense interest of a girl naturally eager for romance and charmed to find her own story full of it. The gushing sentiment with which she greets every part of the story, shown in her intense little speeches, "O, good sir, I do!" "O, the heavens," "Alack for pity," "Alack, what trouble was I then to you!" "Would I might but ever see that man!" indicates a disposition that must have been soothing to Prospero, deprived of the applause and love which he had a right to expect as the social reward

[1] The other essays on the characters of *The Tempest* appeared in the *University of Colorado Studies*, Vol. III, p. 63 and p. 229. This series will be followed by essays dealing with the types of human situations. A third series will include a discussion of the whole problem of *The Tempest* and Shakespeare's psychognosis.

of his goodness, learning, and patriotism; but which he missed in his banishment. Miranda's sentiment is of the true breed, not the kind that leads to no corresponding action, like that of Jacques weeping for the deer and neglecting to assist the starving Adam; but the kind that needed only occasion to be realized as practical love. All the wealth of sentiment occasioned by the sight of the shipwreck and raised and intensified by the exciting story of Prospero's earlier tempest, is a preparation for her meeting with the young prince. She falls asleep in spite of her excited feelings, as though composed to rest by her father's magic. Her visit to Caliban, in which she lashes him with scorn and contempt, intervenes between her waking and the fateful meeting. Her attitude toward Caliban is one of sincere disgust. Her opinions in general coincide with those of Prospero, but she is not endowed with his masculine and practical qualities, she is not "any god of power," and she is emotional and inexperienced.

The scene makes it clear that she has been endowed with an ideal feminine character by heredity, and that she has grown up in an atmosphere of natural freedom, kindness, and learning. While she is governed by right principles, she holds these rather as likes and dislikes than as rules of conduct.

It is with much art that Prospero says, "The gallant that thou seest was in the wreck." Miranda's conduct in this scene with Ferdinand reminds one of a criticism of the pedimental statues of the Parthenon; they seem to have been studied from natural models, but such as we never have the good fortune to see. Miranda solves, or rather is, the concrete solution of the question of the freedom and equality of women. The boldness of perfect sensibility and exquisite refinement cannot be out of keeping with the ideal feminine type. Artificial modesty is essential to a convention where the feelings are more or less unnatural. The best rules approach the best impulses as guides to graceful and appropriate conduct. It is prudent to rely upon the best rules. But where nature gives deportment with refinement, what need is there of a convention? Those who might retort that Sycorax and Caliban are perfectly natural have yet to understand the meaning of the progressive refinement of instinct. Perfect human grace is nature's own seal of refinement with balance; but there is the animal grace of the tiger, and the spiritual grace of a fairy. Miranda is a woman, partly of earth and partly of spirit, and on her own level of progress she is well balanced and instinctive. When the social forces are ill balanced in a character, the conventional restraints give artificial grace; but Miranda is a law unto herself. Perdita growing to womanhood among peasants is yet a queen, and equal in manners to Prince Florizel. Guiderius and Arviragus, without conventional knowledge, are princely; "'tis wonder that an invisible instinct should frame them to royalty unlearned, honour untaught, civility not seen from other."

Miranda not only shows plainly enough her sudden love for Ferdinand, but pleads with her father for him in a manner rather astonishing from the standpoint of Elizabethan usage. Prospero approves of all this. But he acts harshly to Ferdinand. He wishes the thought of Miranda to be associated, not only with Ferdinand's happiness, but with his grief, trouble, labor, endurance, all the varied emotions of life, until she is a part of his habit of thought; until, in a word, every work becomes a labor of love, and his energies are radiated into high activities through her invaluable influence in idealizing him, and herself in him. Before the scene closes she is consoling him in his weakness and discouragement, and thereby associating herself with his strongest emotions.

Scientific criticism must recognize, however it fails duly to appreciate, the massive romantic feeling of this scene. To fail in this is to throw the play quite out of joint. Yet this is precisely the difficulty in estimating this play; to preserve the simplicity of a youthful reader of romance, and to estimate the subtle motives of Prospero; to be synthetic and analytic at once.

The scene reveals Miranda as the daughter of Prospero. The father is a concrete harmonized paradox of the most contrasted qualities—subtlety and simplicity, strength and sensitiveness, social power and love of solitude. The daughter is like him in the feminine sphere—learned but natural, sweet but scathing, infinitely modest, absolutely bold for her rights.

It is in this graceful sublation of the most poignantly contrasted qualities that her character consists. The feminine gentleness of Miranda, and her youth, must not blind the critic to her greatness; she is naïve, but great, and this appears chiefly in her rightness of affection, a strong naturalness guaranteeing lesser goods. She is not bold and modest, or bold in spite of her modesty; her boldness is her modesty. It is not in suffering paradox, but in the vital harmonizing of paradox into a higher grace, that her superior charm consists. Her selfishness is good for the world, yet it is without afterthought. She is the daughter of Prospero, by birth and education, and like him she has that sympathy which identifies self with the social world. She has self-knowledge without self-consciousness, sympathy compatible with dignity and independence; Prospero's wisdom, vast, minute, analytic, is in Miranda a vital instinct, equally sure but smoother; the highest art struck into natural simplicity. She is a return to nature from the extreme refinement of a well-balanced culture.

The fifth scene reveals the lovers in their perfection:

> "The mistress which I serve quickens what's dead
> And makes my labours pleasures."

Labor not for love is labor lost; a futile fever of exertion. Labor performed for affection is the sole cause of progress. All social affections center in and radiate from romantic feeling. This is the poetic philosophy. Miranda's character is massed rather than analyzed. After this scene she speaks only five times, and her speeches are brief and of little importance. Her life and character are summed up in the idea of romantic love used as an encouragement to labor. The sympathies displayed in the earlier scenes, the hatred of the backward Caliban, the boldness in welcoming the prince, the words of support, comfort, consolation which she tenderly lavishes upon Ferdinand, the innocent preference of her lover's company to strict filial obedience, all indicate the one induction, that Miranda is instinctively pervaded by the feminine idea of rewarding danger, exertion, endurance, all means of progress, by sympathy and love. It does not follow that sympathy may not show in exertion, intelligence, activity. She offers to bear the logs herself; but in its ideal stage her character is sympathetic rather than active, and we confidently regard her as a type of feminine romance and chivalry.

> "I am your wife, if you will marry me;
> If not I'll die your maid."

Devotion, constancy, romance, childlike trust and admiration, and childlike boldness and innocence, are some abstract terms corresponding to concrete facts set forth concerning the heroine. The scene suggests that the more willing Miranda is to assist in Ferdinand's log-bearing, the more able Ferdinand is to support the toil for himself and the more unwilling to accept her proffered aid.

In the eighth scene Miranda shows her quick knowledge of her father's moods; in spite of her new love and of her pride in the beautiful masque, she shows her solicitude touchingly.

In the last scene Alonzo discovers his long-sought Ferdinand playing chess with Miranda in the cell. The lovers are playing and gaily quarreling, enjoying their amusement better for the reflection that the logs are piled. Nothing can ruffle their tempers; Ferdinand's greatest right is to yield his rights to Miranda, and Miranda says:

> "Yes, for a score of kingdoms you should wrangle,
> And I should call it fair play."

This, says the ironical scientist, is the usual love-story tone; the central theme of Shakespeare's deepest play can hardly lie in this.

Miranda's last speech provokes Prospero's only cynical, playfully cynical, remark:

> "O, wonder!
> How many goodly creatures are there here!
> How beauteous mankind is! O, brave new world,
> That has such people in it!"
> " 'Tis new to thee!"

remarks Prospero, sententiously.

Miranda is a broad type, not loaded with details of character, yet rich in force and brightness, of the ideal feminine character at the age of selection; she appears in every love-story from the earliest mythology to the present novel.

Ferdinand: Adolescent Hero of Romance

In the shipwreck scene Ferdinand is mentioned as at prayers with his father, King Alonzo of Naples.

In the second scene he appears, following Ariel, or rather Ariel's music. He attributes the music to supernatural causes. As he sat weeping the loss of the king the music crept by him upon the waters. "This is no mortal business, nor no sound that the earth owes." In this mood transported by heavenly music, he sees and loves Miranda—"Most sure, the goddess on whom these airs attend." He declares his wonder and admiration immediately. He speaks of himself with pride as one accustomed in the world to receive homage on account of his rank as well as his merit. Prospero, assuming his harshest manner, curbs the prince's pride somewhat sneeringly. Ferdinand manfully resists the magician's severity, but is charmed into helplessness.

"Put thy sword up, traitor;
Who mak'st a show, but dar'st not strike, thy conscience
Is so possessed with guilt."

"Thy nerves are in their infancy again,
And have no vigour in them."

To these harsh judgments Ferdinand replies,

"So they are;
My spirits, as in a dream, are all bound up,
My father's loss, the weakness which I feel,
The wreck of all my friends, or this man's threats,
To whom I am subdued, are but light to me,
Might I but through my prison once a day
Behold this maid. All corners else o' the earth
Let liberty make use of; space enough
Have I in such a prison."

It is the old story of the imprisoned knight dreading the captivity that prevents him from the daily sight of the fair lady. Our first impressions of Ferdinand are of a young man depressed by misfortune, susceptible to music and beauty. Under the spell which binds up his nerves he preserves his courage and self-respect and undiminished faith in the consoling power of his sudden attachment to Miranda. Throughout his speeches there is a certain pride, partly consisting of manly confidence and partly of pride of place and worldly prospects:

"O! if a virgin,
And your affection not gone forth, I'll make you
The Queen of Naples."

There is a good share of manly independence in the tone of this.

Ferdinand's fate is a common topic among the king and his followers. Antonio's conspiracy rests on the assumption that he is drowned. "Will you grant with me that Ferdinand is drown'd?" Sebastian replies: "He's gone." Gonzalo alone had faith in the future of Ferdinand.

In scene 5 Ferdinand's speech on love and labor shows his real depth of thought and feeling. His pride is not vain superciliousness, or he would be enraged by the crabbed injunctions of the father. The noble humility with which he waives his rank and performs labors so deeply offensive to him suggests that in true love alone can be found the basis of the unreasoning reasonableness by which man relinquishes his rights and becomes what scientists call a moral being: "for your sake am I this patient log-man." This feeling conserved and irradiated offers a basis for the poetic ethics; but Ferdinand's love is not to be confused with a barbarous attachment, a selfish bargain, or a conventional contract. His profession of attachment, though ardent, shows that he is spiritual as well as sensual: "I love, prize, honour you." The scene calls for no comment, it is sufficiently elevated and spiritual to guarantee constancy under fairly favorable conditions.

In the eighth scene Ferdinand is accepted as a son by Prospero. He takes the injunctions of Prospero well: "The strongest suggestion our worser genius can, shall never melt mine honour into lust." This perception and frank discussion of the conflicting spirits of honor and sensuality show the clear head and character of Ferdinand. Like other lovers, he is not marked by brilliant actions or original speeches. Bassanio's splendid, generous character is shown by the love he commands in all who know him. And so Ferdinand is to be accepted as a fitting hero for what he is to Prospero and Miranda, rather than for what he does or says.

In the ninth scene he appears as the happy lover, resting from his labors. His final speech in its frank, vigorous but respectful manliness sums up one's impressions of the hero of *The Tempest*.

"Sir, she is mortal:
But by immortal Providence she's mine;
I chose her when I could not ask my father
For his advice, nor thought I had one. She
Is daughter to this famous Duke of Milan,
Of whom so often I have heard renown,
But never saw before: of whom I have
Received a second life: and second father
This lady makes him to me."

To the romantic reader Alonso's reply redeems all his faults; with simple dignity he answers this impetuous eloquence:

"I am hers;
But oh how oddly will it sound that I
Must ask my child forgiveness."

Ferdinand and Miranda are types of lovers of the best class, in whom a degree of natural warmth and passion is blended harmoniously with the finest spiritual singleness. Ferdinand is more selfish and strong than Miranda, Miranda more clinging and sympathetic than her lover. They stand on the same plane of civilization as Antonio and Gonzalo; but, while the latter pair illustrate the extreme types of selfishness and unselfishness, and are divided by the whole sweep of social differences, the lovers illustrate that mutual give-and-take which gives them a kind of unity in their relation or, as the poetic philosopher has said, "Reason in itself confounded, saw division grow together;" and, in another place, "Number there in love was slain;" and yet again, "Property was there appalled, that the self was not the same."

THE MATHEMATICS OF LIFE INSURANCE[1]

By S. Epsteen

§ 1. Introduction

Just as everybody eats bread without knowing its chemical composition, so everybody uses insurance without understanding its nature. Insurance is a guarantee of indemnity; its object is to replace money or other property that is lost. The theory of the system is this: Many people who are subject to a common danger of financial loss agree to pool their expected losses by providing in advance, by general contribution, a fund from which those who actually suffer loss may be indemnified.

If a man insures his house for exactly what it is worth, say \$5,000, and pays \$50 per year, and the house burns, he receives \$5,000. Thus he is in almost as good a position financially as before, having lost only the amount of the premium—\$50. In this respect, however, he is in exactly the same position as every other man insured for a like amount on equally valuable property and at the same time—each of them has lost exactly \$50 and each has \$5,000 less \$50. The fact that one man has \$5,000 in cash and the others each have \$5,000 worth of house does not affect the comparison. It is thus seen that insurance is a co-operative scheme whereby each member of the community pockets a small loss in place of one member sustaining a severe loss. The insurance company acts as an intermediary in distributing this loss.

Life insurance does not insure life in quite the same sense that fire insurance insures a house or marine insurance a ship. Should the house burn or the ship sink the insurance company can (and sometimes does) substitute another for it. But one cannot substitute a new life for the one terminated. In life insurance one insures the product of the effort which a man exerts when alive (and which he cannot exert when dead), and not life itself.

[1] Read before the University of Colorado Scientific Society, January 29, 1906. In preparing §1 I have followed Campbell's *Insurance and Crime*, Introduction, and in § 3, *Educational Leaflets* No. 2, issued by the Mutual Life Insurance Co. of New York.

§ 2. The Mortality Table

In this country premiums are computed on the basis of the American Experience Mortality Table (see p. 37). The table begins, not with birth, but with the age of ten, for two reasons. First, the law of infant death-rate is unknown, and, secondly, it is illegal in most states (Colorado included) to insure children under that age. It was found necessary to pass this law on account of the large number of children who were put to death for the insurance money.

The fact that out of 81,822 men, age 35, 732 died, is no proof, theoretically, that 732 will die out of the next 81,822 of the same age. Experience shows, however, that the number will be astonishingly close to this. You will see later that in the computations based on this table, the theoretical net premiums are increased by the so-called loading to allow for an unexpected excess in mortality. As a matter of fact, the above table is very conservative, and the death-rate is not so high as there indicated. Especially during the first five or six years, before the influence of the selection by the preliminary medical examination has disappeared, the actual mortality is a rather small percentage of the tabular mortality rate.

§ 3. The Net Single Premium

To begin with, it will be shown, by a typical example, how life insurance premiums are computed. The solution is outlined for the age 35, but it will be apparent that the method is perfectly general and can be employed to find the premium at any other age. For the sake of illustration, the policy is supposed for $1,000; of course, a policy for $5,000 would cost five times as much, one for $10,000 would cost ten times as much. So that the method about to be given (which is, at bottom, the one actually employed in the construction of the tables for the insurance companies) serves to determine the premium at any age and for any amount.

Let us suppose that a life-insurance company is organized, consisting of 81,822 persons each 35 years of age and each insured for $1,000 payable at death. For convenience we take the figures 81,822 as our total membership that being the number of persons still living at age as given in the mortality table of § 2. It is also for convenience—to make

TABLE I

American Table of Mortality

Age	Number Living	Deaths Each Year	Death-Rate per 1,000	Age	Number Living	Deaths Each Year	Death-Rate per 1,000
10	100,000	749	7.49	53	66,797	1,091	16.33
11	99,251	746	7.52	54	65,706	1,143	17.40
12	98,505	743	7.54	55	64,563	1,199	18.57
13	97,762	740	7.57	56	63,364	1,260	19.88
14	97,022	737	7.60	57	62,104	1,325	21.33
15	96,285	735	7.63	58	60,779	1,394	22.94
16	95,550	732	7.66	59	59,385	1,468	24.72
17	94,818	729	7.69	60	57,917	1,546	26.69
18	94,089	727	7.73	61	56,371	1,628	28.88
19	93,362	725	7.76	62	54,743	1,713	31.29
20	92,637	723	7.80	63	53,030	1,800	33.94
21	91,914	722	7.85	64	51,230	1,889	36.87
22	91,192	721	7.91	65	49,341	1,980	40.13
23	90,471	720	7.96	66	47,361	2,070	43.71
24	89,751	719	8.01	67	45,291	2,158	47.65
25	89,032	718	8.06	68	43,133	2,243	52.00
26	88,314	718	8.13	69	40,890	2,321	56.76
27	87,569	718	8.20	70	38,569	2,391	61.99
28	86,878	718	8.26	71	36,178	2,448	67.66
29	86,160	719	8.34	72	33,730	2,487	73.78
30	85,441	720	8.43	73	31,243	2,505	80.18
31	84,721	721	8.51	74	28,738	2,501	87.03
32	84,000	723	8.61	75	26,237	2,476	94.37
33	83,277	726	8.72	76	23,761	2,431	102.31
34	82,551	729	8.83	77	21,330	2,369	111.06
35	81,822	732	8.95	78	18,961	2,291	120.83
36	81,090	737	9.09	79	16,670	2,196	131.73
37	80,353	742	9.23	80	14,474	2,091	144.47
38	79,611	749	9.41	81	12,383	1,964	158.60
39	78,862	756	9.59	82	10,419	1,816	174.30
40	78,106	765	9.79	83	8,603	1,648	191.56
41	77,341	774	10.01	84	6,955	1,470	211.36
42	76,567	785	10.25	85	5,485	1,292	235.55
43	75,782	797	10.52	86	4,193	1,114	265.68
44	74,985	812	10.83	87	3,079	933	303.02
45	74,173	828	11.16	88	2,146	744	346.69
46	73,345	848	11.56	89	1,402	555	395.86
47	72,497	870	12.00	90	847	385	454.54
48	71,627	896	12.51	91	462	246	532.47
49	70,731	927	13.11	92	216	137	634.26
50	69,804	962	13.78	93	79	58	734.18
51	68,842	1,001	14.54	94	21	18	857.14
52	67,841	1,044	15.39	95	3	3	1000.00

the problem as simple as possible—that we assume that each member of our company will maintain his membership during his entire lifetime, and that no new members will be added after the date of organization.

The 81,822 members of our company will all die within the next 61 years, making a total ultimately to be paid of $81,822,000. This enormous sum is to come entirely from the premiums that are to be paid by the members and the interest which these premiums will earn. The problem is to determine how large a premium each member must pay in order to create a fund sufficient for this purpose.

It is not known how long any particular member of our company will live. The amount that each member should pay, therefore, cannot be determined by means of a computation based on a single life. But if it is not known how long any one individual will live, it is known how long certain groups of members will live. For example, the mortality table shows at age 35 that 732 members will live only 1 year, 746, 2 years; 812 will live 10 years to age 45; 1,143, 20 years to age 55; and that 3 will live 61 years to age 96. The computations must therefore be based upon the aggregate number of lives, the length of time the members will live as a body, as shown in case of these several groups. Although it is customary to pay immediately upon proof of death, it is here assumed, for the sake of simplicity, that payment is made at the end of the year in which the deaths occur.

Since 732 die the first year, the company will have to pay out $732,000 at the end of the year. It is not necessary, however, to have the full sum on hand at the beginning of the year. The present worth of $732,000 is $707,258.40; that is to say, if one invests $707,258.40 at $3\frac{1}{2}$ per cent. interest, it will amount to $732,000 in one year. Similarly, since 737 die during the second year, the additional liability of the company at the end of the second year is $737,000. Now, if $694,693.18 is invested at $3\frac{1}{2}$ per cent. for two years, it will accumulate to $737,000—the amount of the second year's death claims.

The following table shows how this method is applied up to the end of the mortality table. In the third column the present values of the losses (shown in the second column) are given. The fourth column contains the formula by means of which the third column is computed.

TABLE II

I Age	II Losses	III Present Worth of Losses	IV Formula for Computing III
35	732,000	707,258.40	$\frac{732,000}{1.035}$
36	737,000	694,693.18	$\frac{737,000}{(1.035)^2}$
..	....	....	....
44	812,000	575,626.80	$\frac{812,000}{(1.035)^{10}}$
..	....	....	....
54	1,143,000	574,471.80	$\frac{1,143,000}{(1.035)^{20}}$
..	....	....	....
95	3,000	367.93	$\frac{3,000}{(1.035)^{61}}$
Totals....	81,822,000	30,319,142.10	

The dots represent the other years, as given in the complete mortality table for the several ages from 35 on, the figures for which may be determined in the same manner.

With this amount on hand today, on the assumption that the same will earn 3½ per cent. interest, we shall have funds sufficient for the payment of every loss that can possibly occur in any year until the last 3 members die. This amount divided by 81,822, the number originally insured in our company, gives $370.55. In other words, if each member of our company will pay in cash the sum of $370.55, we shall have at date of organization a total of $30,319,142.10, or sufficient to pay every existing policy in full as the several deaths occur.

This $370.55 is termed the "net single premium," and is the *net* amount, without provision for expenses, which a man at age 35 should pay for a full-paid policy of $1,000.

§ 4. The Net Annual Premiums

The net single premium having been deposited, no further payments would ever be required; but most men would find it inconvenient to pay for their life insurance in a single sum. By means, however, of an equally simple mathematical process we may apportion that net single premium into an equivalent twenty payments to be made annually.

I shall not take your time this evening in going through the details of this calculation, but shall content myself with a statement of the principles involved and the result obtained. The net single premium of $370.55 is worth more than 20 premiums of $18.53 each, although $\frac{370.55}{20}=18.53$. The reasons for this are easily seen. Suppose two men, A and B, each 35 years of age, take out policies for $1,000; A paying in 20 premiums and B in a single premium. Let us compare the accumulations on these policies after the expiration of twenty years. Suppose the company charges A (erroneously) the net sum of $18.53 per year. His first $18.53 would therefore be invested for 20 years, the last $18.53 for only 1 year. The second $18.53 would be invested 19 years, the next to last $18.53 for only 2 years. Thus on the average the company has the use of A's $370.55 for 10½ years. It has the use of B's net single premium of $370.55 for 20 years, however. Clearly, then, on account of the difference in interest accumulations, $18.53 per year for 20 years is not equivalent to $370.55 paid in a lump sum, in advance.

Moreover, some of those whose policies are on the 20-pay plan will die before the expiration of the 20 years, and a certain number of premiums will thus be lost to the company; and this loss, as well as the one mentioned above, must be counterbalanced by an extra charge to the survivors.

Calculations based on these two principles show that a single payment of $370.55 is equivalent to a promise, made by a man 35 years of age, to pay $27 per year for 20 years. Thus the *net* value of a 20-pay life policy at age 35 is $27 (in round numbers).

In the second column of Table III I give the net annual premiums, at five-year intervals, for the ages 25 to 40. In the third column are given the gross premiums,[1] for the same ages.

TABLE III

I Age	II Net Premium	III Gross Premium
25	21.50	30.25
30	23.60	33.20
35	27.00	36.87
40	29.30	41.46

[1] These gross premiums, differing slightly with the various companies, are necessarily only approximate.

§ 5. The Loading—The Gross Premium

We see from the preceding that it costs the company \$370.55, or \$27 per year for 20 years, to insure a man, age 35, for the term of his natural life. Evidently, then, the actual office charge must be somewhat larger. The additional charge, or so-called "loading," must be sufficient to cover the various expenses—physician's fees, agent's commission, canvassing literature and supplies, and salaries of officers. It must also furnish a fund—a surplus—to provide for all other possible contingencies—such, for instance, as a mortality in excess of the tabular rate, interest earned less than the assumed rate of $3\frac{1}{2}$ per cent., depreciation in the values of securities, loss of invested funds, etc. While the assumptions as to interest and mortality in the computation of the premium have been on the most conservative basis, nevertheless, so long as human judgment is fallible the possibility of error must be conceded. The fundamental principle of life insurance is safety, and, if mistakes are made at all, they must be on the side of safety. It is better to collect too much money than too little; hence the importance of making provision for unforeseen contingencies. Theoretically, when these contingencies are past, the overcharge is returned to the policy-holder in the form of dividends.

$$\text{The net premium} + \text{loading} = \text{gross premium}$$

or,

$$\text{Loading} = \text{gross premium} - \text{net premium}.$$

If the loading is divided by the net premium, the percentage of loading is obtained. In Table IV is given the percentage of loading of six-

TABLE IV

Company	Percentage of Loading (20-Pay Life, age 35)	Company	Percentage of Loading (20-Pay Life, age 35)
Aetna	$34\frac{4}{5}$	Mutual Life of New York	$34\frac{1}{2}$
Boston Mutual	$33\frac{1}{2}$	New England Life...	$31\frac{2}{5}$
Connecticut Mutual	20	Northwestern	$26\frac{3}{5}$
Equitable	$28\frac{1}{2}$	New York Life	$28\frac{1}{2}$
Home Life	$32\frac{7}{10}$	Pacific Mutual	$33\frac{1}{3}$
Maryland Life	$33\frac{3}{5}$	Provident	$23\frac{1}{2}$
Massachusetts Mutual	$33\frac{3}{5}$	Prudential	24
Mutual Benefit	$21\frac{1}{8}$	Union Central	$29\frac{1}{2}$

teen well-known companies, on a 20-payment life policy, issued at age 35.[1]

§ 6. Dividends

At age 35 a 20-payment non-participating policy (on which no dividends are paid) costs, in round numbers, $31; that is to say, the company charges $4 per year for 20 years for expenses.

A participating policy at the same age (on which dividends are paid) costs about $37 per year; i. e., a loading of about $10. Deducting the $4 for expenses, you see there still remains $6, which goes into the surplus fund, to be returned, ultimately, as dividends. In some of the companies this fund has grown to between sixty and eighty millions of dollars. Nominally this money is all returned to the surviving policy-holders. The recent exposures in New York have shown how these funds have been employed for speculative and various questionable purposes.

Dividends are actually paid to the policy-holders. Deferred dividends should come from the following sources: savings in expenses (which experience shows are seldom made), interest earnings in excess of the estimated 3½ per cent., return of the original overcharge, and apportionment of the dividends of those who died.

§ 7. Surplus

The dividends deferred for twenty years have given rise to immense accumulations of wealth in several of the companies. Although the recent investigations have shown that it is unwise to allow the officers to manage such large sums without an accounting until the expiration of two decades, it must not be overlooked that the arguments which they employed in building up the present system are plausible ones.

First of all is the matter of safety. You doubtless remember the panic of 1893. At that time one of the companies, at least, was practically insolvent, but has since recovered, and, to provide against a similar contingency, has created a surplus of nearly $80,000,000. The recurrence of the same state of affairs today might wipe out part of the

[1] Some of these companies are on the 3 per cent. reserve basis, others on the 3½ per cent. basis. In all cases I have made due allowances for this in determining the percentages.

surplus, and lose for the policy-holders most of their dividends; but the policies proper would be safe. Another argument frequently advanced is that many men are unable to save small sums of money, but, being obliged to pay their premiums, are thus in a measure compelled to save each year a certain amount, which in the course of twenty years accumulates to respectable proportions. While arguments could be advanced against this, it is, however, true that the point is, to a certain extent, well taken.

It is clear that, in order to insure the safety of the reserve—that is to say, of the policy proper—there ought to be a reasonable surplus. On the other hand it is equally clear that the officers of the company should not be permitted to manipulate the intrusted funds without being accountable to the policy-holders. Perhaps the solution of this difficulty lies in reducing the surplus, in some of the companies, to about one-fourth or one-fifth of the present dimensions, and the requirement of an annual statement to each policy-holder of his share in the year's profits.

But, aside from the fact that deferred dividends and the resulting large surplus funds lead to speculation, extravagance, and all manner of graft, there is another strong argument against this system. Even if by means of annual statements to the policy-holders and other methods of publicity the present evils were eliminated, the objection about to be given would still hold.

The principle of deferred dividends is in direct antithesis to the principle on which insurance is based. In insurance, the loser (i. e., the one who dies, or, in fire insurance, the one whose house is burned) is indemnified for his loss. The one who wins (i. e., who survives, or whose house does not burn) gets his money's worth in the *protection* he has enjoyed.

With deferred dividends the contrary is the case: the one who loses (i. e., dies) loses his dividends, and the one who wins (survives) gets the share belonging to his less fortunate neighbor. You see, this is exactly what happens in horse-racing: the one who guesses wrong pays, while the one who was correct in his surmise, wins. To summarize: Insurance is indemnity for loss, while deferred dividends is pure gambling.

§ 8. The Regulation of Life Insurance Companies

The desirability of federal regulation of life-insurance companies is so generally recognized that it is unnecessary to advance arguments in its favor. But the decision of the Supreme Court that insurance is not commerce[1] seems to have taken the matter out of the reach of Congress. There are some optimistic insurance men who believe that the Supreme Court would, in view of developments since 1868, rule that *the interstate insurance business is interstate commerce*,[2] but for the present this decision constitutes a serious obstacle in the way of national legislation. Direct methods being thus impractical, the following indirect method has recently been proposed:

Congress, having jurisdiction in the District of Columbia and in the territories of the United States, could appoint a competent commission to investigate the conditions and methods of the various companies, and authorize or forbid them to do business in the District of Columbia and in the territories. Of course, such investigation would have to be voluntary on the part of the companies; any company, so desiring, would be at liberty to refuse to permit such an examination. Suppose, however, that the agents of three companies, A, B, and C, are trying to get your business. Company A has been investigated by the government and pronounced satisfactory; B has been investigated and pronounced unsatisfactory; while C has declined to allow the government to examine its affairs. Clearly, you would not trust B with your money, and you would be exceedingly suspicious of C, wondering why it is afraid to allow its books to be examined. You would undoubtedly select A as the safest company to insure with, and thus, A getting all the business, B and C would soon have to wind up their affairs.

Most of the insurance companies are organized on the mutual plan, wherein every policy-holder has a voice and vote in its government. In practice this suffrage is a farce. No one from afar ever goes to the annual meeting to cast his vote, and those living in the city where the meeting is held have not the time to attend it. When policies are taken out, the purchasers give their proxies to someone suggested by the

[1] This decision was handed down in December, 1868, in the case of Paul vs. Virginia.

[2] J. F. Dryden, Address on the regulation of insurance by Congress.

agents, and this person has control of the company. This individual is, of course, a puppet in the hands of the officers of the company, at whose instructions the agents suggest his name. Thus, once in power, the officers of a mutual company have no difficulty in continuing so indefinitely.

The idea of a mutual organization, the members going each year from California to New York to vote at an election, is as absurd as the idea of all the citizens of the United States going annually to Washington to enact laws. In classic Greece the ideal government was a city of ten thousand, for then all citizens could come together and settle matters of state. This being out of the question in a great land like ours, a different principle is employed—the principle of representation.

Similarly, insurance companies should be representative instead of mutual, as conducted at present. The most convenient grouping for the purpose of electing representatives would probably be according to states. The policy-holders of each state could elect someone (a competent actuary) to represent them at the annual meetings of the various companies. Besides acting as a legislative body for the companies, these representatives could make annual reports to their constituents concerning the conditions of the companies. Of course, this scheme involves some expense, but each policy-holder's pro-rata share would be trifling. Fifty cents to one dollar per year would be sufficient, while the improvements and savings which these representatives could bring about (and consequent deduction in the cost of insurance, or increase in dividends) would be, relatively, very large.

VOLUME IV NUMBER 2

THE UNIVERSITY OF COLORADO STUDIES

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PUBLISHED BY THE
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Price, 50 Cents

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CONTENTS

SIGNIFICANCE OF THE BANKING SITUATION IN COLORADO

By John B. Phillips

This paper concerns itself mainly with that part of the financial situation that is represented by the banking laws. Many causes have been operative in making the banking situation what it is in this state, and these causes are now operating to bring home to the minds of the people the need of certain changes in our banking legislation.

For many years Colorado was a frontier state. It was on the border between the developed and undeveloped resources of the United States. As a frontier state its population was engaged in exploiting undeveloped resources. For this purpose a different class of people is necessary from the kind of persons suited to carry on the industries in an older and more thickly settled region. In the frontier state the settlers must live distant from each other, hardships must be endured, self-reliance must abound.

These demands of the frontier had their effect on the immigrants that came here. Those men and women who left their homes in the East and came to develop the resources of our state were strong, healthy, aggressive and ambitious. The timid young men and women remained in the eastern states and engaged in the routine industries. The restless, adventurous, and daring young men and women came to seek their fortune in the new lands of the West. This is why so many of the captains of industry and leaders in politics are men trained in the enterprising spirit of the West.

In the history of the United States there is no more conspicuous fact than that the leaders from the very beginning have been men trained in the West. The frontier it seems has developed the dash and enterprise necessary to the leader. The West has always had an influence on the history of the country out of all proportion to its numbers. Washington, Jefferson, Jackson, Harrison, Taylor, and Lincoln were all men of the frontier. They represented the West. The War of 1812 was a war of the western people. It was pushed through against the opposition of the eastern section of the country. The western young men were in Congress and they made their influence felt. This they have not ceased to do notwithstanding the fewness of their numbers nor the scattered constituencies they represent.

One of the most significant effects of the frontier has been its encouragement of democracy. The doctrine of equal rights for all the population, man, woman, and child, finds its fullest expression in the legislation of the newer states of the West. This is the region where special privileges are likely to be the most unusual. The ideal of liberty is seldom lost sight of and a feeling of personal freedom quite unknown in the eastern lands of steady habits is the abiding prerogative of every citizen. Such a condition of affairs, such an intense democracy has tended to cultivate in our population a boundless spirit of self-reliance. The western states are the last ones to think any sort of paternal legislation necessary. They are the states that are most likely to be opposed to the state regulation of industry.

Aside from having been a frontier state, Colorado has been and is today very largely a mining state. The character of its population has been in some degree affected by this industry. Mining is a different industry from many of the more routine occupations. It is quite different from agriculture. A very different type of mind is needed to succeed in the mining industry from the type of mind needed for success in agriculture. There are ups and downs in the mining business. A large element of risk is always present. It calls for adventurous men. Timid men do not engage in the mining industry. Men of daring willing to play for large stakes are needed to develop a mining state.

Men with these traits of mind are restless and more or less unsettled. They are likely to be discontented when compelled to carry on routine industry yielding small returns. The prospect of sudden riches by strikes in mining makes the quiet life in routine industry dull and distasteful. A rich mining strike tends to start a speculative fever in the population. And in a population for many years engaged in this kind of industry there is a readiness to undertake speculative enterprises that is not found in the more lethargic states where only routine industry prevails.

What is here said was more true of the population of Colorado in the early days than is the case now. Yet the effects of this early period have not been entirely obliterated from the population of today.

Such in a general way are the characteristics of our population. It is well that we have this kind of a population for just these qualities are still very largely needed to develop the magnificent possibilities of this state. We have hardly done more than make a beginning in the development of the resources here. A glance at the industrial map of the state shows that agriculture has been developed in but few sections. Its possibilities are vast. Improved processes in mining will greatly increase that industry. We need more railroads to open up some of the most fruitful sections of the state. And in manufactures why must we be dependent upon goods made in the eastern states? There seems to be no good reason why manufactures of all kinds should not develop in the state of Colorado. There is reason to hope that in the future even in spite of the discriminating railroad rates a great multitude of manufacturing concerns will make their homes on our soil.

Now what are some of the fundamental needs for the development of the possibilities of our state? We need an aggressive population. This we do not need to worry about. The kind of immigrants who come here will be men of enterprise. As a rule we are not likely to get a poor class of men to undertake the management of the industries. In industrial efficiency our population is now superior to that of many states, and there is reason to believe that the newcomers will not be inferior.

We need capital. This will come in the course of time. The higher rates of interest, the growth of sound credit, and the minimizing of the element of risk will bring in capital in abundance from other states. Among these the growth of sound credit and confidence is of very great importance.

Modern industry demands more credit and confidence than were needed in the earlier times. There has been a great increase in co-operation, specialization and division of labor. There is more interdependence in the modern world. Our water supply no longer comes from our own well; our meat is canned in a distant city. We are co-operating and must place confidence in the honesty and good judgment of others.

The magnitude of modern industry has increased. There is greater competition in business. Modern business is done on credit, and, owing to the increase in competition and the size of industries, larger loans and more credit are constantly demanded. Therefore the result is an increase in the use of credit. Individuals who did not think of using credit a dozen years ago are now demanding it and having secured it are engaging in new enterprises.

The services of credit are of inestimable value in industry. Property cannot always be sold when the owner desires purchasing power. By the use of credit, however, property can be coined into money and exchanged for goods. The result is that the management of industry is put into the hands of the most capable managers by this use of credit. Individuals who happen to have the money on hand are not always the most capable to undertake the management of industry.

Credit is obtained through banks. They are the credit institutions of society. They flourish by having the confidence of the community. Their business is to coin goods into a means of payment. Their services in turning goods into credit and in this way encouraging the growth of industry and the progress of civilization are beyond measure.

The banker turns goods into purchasing power on his own responsibility. He alone decides how much credit shall be given in any case. He determines how large the mortgage on the house or farm shall be, and how large a loan on the various kinds of collateral offered may safely be given. The importance of good judgment in the banker is at once apparent. Poor judgment brings a banker to speedy financial ruin. The test of good banking is whether or not there is an actual movement of goods back of the credit given.

Banks give two kinds of credit, normal and abnormal. Normal credit is credit given for goods. It expands with growing wealth and the increase of commodities. When credit is given based on goods there is not likely to be an undue expansion of it. The expansion of this sort of credit is not to be feared and its effect on the general price level can not be more than temporary.

On the other hand, abnormal credit is quite a different and much more serious matter. This kind of credit is an increase of purchasing power beyond the value of the goods owned. It may and usually does cause speculation and rising prices. When it is easy to get more credit than the collateral is worth, speculative enterprises will be undertaken. The industrial world is intoxicated. Hope abounds. Stock in the Keeley Motor Company can easily be sold. Conditions are established for growing tulips in Holland, and blowing bubbles in the South Sea. In short the foundations for commercial crises may be laid in this way.

There are two causes of abnormal credit. One is error of judgment by the banker, and the other is conscious fraud. It is possible for all human beings to err in their judgments of the values of commodities and securities. In a period of rising prices, it is exceedingly hard to tell whether the prices represent a healthy growth of industry or are the result of credit too freely given. The banker is liable to err at such times as are all the rest of us. It is said, however, that this is the unimportant cause of abnormal credit. The chief cause is believed to be conscious fraud. Excessive loans are made to promoters, and again, the directors are interested in some enterprise needing an excessive loan for its financiering. Their bank accordingly makes the loan. Sometimes they organize themselves into a separate company, and borrow largely from their bank. In this way, then, the greater amount of abnormal credit comes into existence. In any case the amount of credit to come into existence is very largely determined by the banker.

It is thus apparent that the power of the banker over industrial conditions is very great. He regulates the amount of credit and, as the industries of the country are conducted on a credit basis, he also to a large extent regulates the industries. Hence, the importance to the community of the good judgment and honesty of the banker. There is perhaps no class in the country whose judgment and honesty are so closely associated with our industrial progress. Upon no one class of men does the welfare of any community depend more than upon its bankers. It is therefore of the highest importance that society do what it can to place its bankers in an environment that will secure the wisest and most impartial of their judgments in the matter of extending credit to those about to undertake the management of industry. In so far as it can society should seek to minimize the temptations incident to the banking business.

There are two kinds of temptations in banking. Those incident to the fiduciary relationship, and those due to competition under modern conditions of life.

Banking is largely a fiduciary occupation. The banker possesses the confidence of the community and has on hand a large amount of money belonging to other persons and this he knows will not be called for during a considerable period of time. He also knows of many promising opportunities for investment of which the general public is entirely ignorant. He is familiar with the gigantic schemes of the promoter, and he is also acquainted with the tricks of corporation finance. In consequence, he is tempted more than other classes in the community to engage in speculation. Brokers in the larger cities say that it is not uncommon for bankers in the smaller places to furnish them money with instructions to go long or short on certain kinds of stocks.

Under modern conditions of industrial and social life competition is fiercer for the moneyed classes. The banker belongs to these classes. There is a certain cleavage in society between these and other classes. The financial interests are sharply defined. Standards are set by the leaders in financial and banking circles. The small banker tries to live up to the standard set by the great banker. This is conspicuously shown in the modern race to build elegant bank buildings. In the advertisements that are now running in the banking magazines it is quite the thing to have a picture of the building. Especially is this the case if the building is a fine one. Everyone is familiar with instances where one bank in a city has put up a fine building and the other banks have not been slow to build also and to try and surpass the buildings of their competitors. What is true of the buildings applies also to the interior furnishings. A series of articles is now running in the *Bankers' Magazine* showing the interiors of the more important banks in the larger cities of the United States. Nearly all the illustrations are of interiors finished in marble. Formerly bank fixtures were in some sort of wood, but with the increase of wealth in the country it seems that only marble will answer the purpose. These articles show if they show anything that there is a most fierce competition in the matter of bank fixtures and furnishings. It is true the public is frequently foolish enough to allow its patronage of a financial institution to be in some considerable measure determined by the elegance of the interior of the banking-house. It would seem, however, that with the revelations the past two years have made in the management of great financial institutions, the public will in the future be more attracted by the character of the banker than by the elegance of marble fixtures and sumptuous furniture. If this is true such extravagant banking houses will be less necessary in the banking business of the future.

Competition has developed another practice among the banks that is generally regarded as unfavorable to sound banking. This is the practice of paying interest on deposit balances. Superintendent Kilburn of New York says that the banks in his state are paying too high rates of interest on these balances. The banks do this in order to get money, and are thus tempted to loan on poorer security as it will pay a higher rate of interest. He thinks this is a matter that the banks and trust companies should settle among themselves. The banks in Albany made an agreement in 1905 not to pay interest on balances under $10,000. The agreement was a success. Very little money it is said was withdrawn from the city in consequence.[1]

These general considerations on the effect of competition in the banking business apply with much force to Colorado. Our bankers are exposed to the same temptations that confront those in other states. They must regulate the amount of credit to be given and they must also prevent the growth of abnormal credit. This is not easy. It has been shown that our population is composed of aggressive and adventurous pioneers and their descendants as well as a large element of enterprising immigrants from other states. Come to seek their fortune in the West, they bring little capital and they want credit. Our own citizens are optimistic; they have faith in speculative enterprises. The fever of speculation brought on by the development of mining in this state has not yet entirely run off. Fortune-seeking immigrant and optimistic

[1] "Report of Supt. of Banks, N. Y.," *Bankers' Magazine*, Vol. LXXII, p. 110, 1906.

prospector and promoter make their appeal to our bankers. Whether or not too much credit shall be given them depends upon the banker's judgment. This is why we need banking laws that will assist the banker in deciding wisely, and thus protect ourselves from an undue expansion of credit and its consequent injury to sound business enterprise.

Among the more important defects in the banking laws of Colorado are confusion and the absence of supervision. There is confusion in the law which defines the banking powers of trust companies.[1] The law enumerates the powers of trust companies and seems to include all the banking powers and then says that these companies shall not engage in banking except as herein authorized. This last clause is of doubtful meaning and just what was the intent of the legislature in enacting it has never been made clear. It looks as though it might have been inserted to make the bill pass easily so that the unwary might not suspect that trust companies had banking powers. It recalls the character of the Manhattan Company of New York City. Some of the anti-federalists, among them Aaron Burr, wanted a charter for a bank in New York. The legislature was then in session but it was a federalist legislature and Burr well knew that it would not grant him a charter. He therefore conceived a method of obtaining one by stealth. There had been an epidemic of yellow fever in New York and it was commonly thought to be due to the poor water supply. Burr went to the legislature and asked for a charter for a company to provide a pure water supply for the city of New York. In the bill which he drew and presented to the legislature was a clause that any surplus of the capital of the company might be employed in any moneyed transactions not inconsistent with the constitution and laws of the state. The federalists, even such astute men as John Jay, did not mistrust that banking powers were concealed in this innocent looking clause. This company immediately started a bank with half of its capital and exists as the Manhattan Company to this day. It long since ceased to be a water company.

The liability of stockholders in banks and trust companies is not clearly defined. The law of 1885 says that shareholders in banks, savings banks, trust, deposit, and security associations shall be individu-

[1] *Laws of 1891*, pp. 102–105, § 3; *Mills' Statutes*, § 544c.

ally responsible in double the amount of the par value of the stock owned by them.[1] The law of 1891 says the stockholders in trust companies shall be liable to the amount of their stock and in addition thereto. What the phrase "in addition thereto" means has not been settled. It may mean that the liability of the stockholders is unlimited. If such be its meaning it is bad as it will tend to check the growth of credit institutions.

Again, in the matter of limiting the loans to any one person, firm, or corporation, the law should be changed. Banks may not loan more than 25% of their capital in this way.[2] Savings banks and trust companies are not hampered by law in the amount of such loans.

The most serious defect in the banking laws of Colorado is the absence of supervision. As has been already pointed out, the people of the West are self-reliant. They do not look with favor on government control. There is a feeling that each citizen can look out for himself. It is difficult, however, for each individual to look out for himself in so important a matter as banking. The state has taken over the coinage of money because it can secure a good money system with less difficulty than any individual, no matter how self-reliant he may be. So of the banking system. The state can by a careful supervision of the banks save energy for the individual. To attain their greatest usefulness banks and trust companies must secure the maximum confidence of the public. The danger of bank failures must be reduced to a minimum. Frequent examinations are an aid to good bank management. Thirty-five states and territories require examinations of their banks and trust companies; some annually, some twice a year.[3] There seems to be a growing tendency to require two examinations a year. State examinations of credit institutions has become a settled principle of American financial policy.

A state superintendent of banks is an important officer and the manner of his appointment is not easy to decide. Above all things this office should be kept out of politics. The national bank examiners are

[1] *Laws of 1885*, p. 264, § 1; *Mills' Statutes*, § 533.

[2] *Laws of 1885*, p. 51, § 1; *Mills' Statutes*, § 223.

[3] Arizona; California; Connecticut; Delaware; District of Columbia; Florida; Georgia; Illinois; Indiana; Iowa; Kansas; Louisiana; Maine; Maryland; Massachusetts; Michigan; Minnesota; Missouri; Montana; Nebraska; New Hampshire; New Mexico; New York; North Carolina; North Dakota; Oklahoma; Pennsylvania; South Carolina; South Dakota; Texas; Utah; Vermont; West Virginia; Wisconsin; Wyoming.

appointed largely through pull.[1] Each examiner makes 150 perfunctory examinations a year. Hence, the contempt for them which is so prevalent among the bankers. Probably the best way to secure a bank examiner or superintendent of banks whose position will not in any way be dependent upon political pull will be to have him appointed by the governor on the recommendation of the state bankers' association. In this way a capable man will be secured and his efficiency will not be injured by the machinations of the professional politician.

When a superintendent of banks has been appointed he should have sufficient power to make his influence effective. He should be empowered to examine banks at any time and on his own initiative. His examination should be thorough enough to make him familiar with the class of loans and their security. Unless he becomes reasonably familiar with the loans of the institution, his examination is of little value. The state superintendent of banks should also have the power to close a bank and apply for a receiver when it is conducted in an unsafe, dangerous, or unlawful manner. In some states this officer has the aforesaid power, though it is not general. The federal officers can close a bank only when it is insolvent. When the state examiner can close a bank if it is conducted unlawfully, a force is set in motion that makes for good banking. Knowing the state officer had this power, the banks would be careful in the management of their business.

Trust Companies

Whatever system of regulating banks may be instituted by the state, it should be applied equally to the regulation and examination of trust companies. These institutions have grown up among the banks for the purpose of meeting the demand for certain financial operations which it was impossible for the banks to perform. In most states the powers given to them are somewhat vague and generally the charters have been construed to give to these corporations banking powers. As a result these companies are generally engaged in the banking business. In many states these institutions are more favored by the law than are banks. This is the case in Colorado as has been pointed out. No

[1] *Bankers' Magazine*, New York, Vol. LXXII, p. 57, 1906.

reserve is required to be maintained by trust companies, nor is there any limit to the amount they may loan to one person. The result of this is the encouragement of an unhealthy competition to get deposits. The companies pay too high rates of interest on balances and the banks are compelled to meet this competition in order to retain their patrons. It is said that trust companies sometimes borrow on collateral and reckon the sums so received with their deposits in order to make a more favorable showing, and in this way attract more trust funds. The concerns not subject to inspection are more likely to resort to schemes of this nature.

In the state of New York supervision of trust companies was instituted in the year 1874. The first year of its operation three trust companies which had been conducted in a dangerous and illegal manner were compelled to suspend operations. $6,000,000 of deposits were paid out in full to their owners.[1] Had no state examinations been made and only reports of the officers of these institutions been depended upon, the three companies might have gone on till a much worse condition prevailed and the depositors might have lost a large part if not all of their money. Before state examinations were begun in New York trust companies had seldom failed whose recently published statements did not show a surplus.[2]

There is a pronounced movement in the United States toward bringing trust companies engaged in the banking business under the same law that applies to banks. The bank examiner as a rule examines trust companies as well as banks and the time is not far distant when the two institutions will be regulated by the same law as far as the business of banking is concerned.

As an indication of the latest tendencies in bank and trust company legislation these acts passed by the last legislature of the state of New York are important:

1. Overdrafts are prohibited to officers, directors, and employees of banks and trust companies.

2. Commission is denied to an officer or director of a bank for procuring loans from that bank to any corporation.

[1] *Bankers' Magazine*, New York, Vol. LXI, p. 787, 1900.

[2] CATOR, "Trust Companies in the United States," *Johns Hopkins University Studies in Historical and Political Science*, Series 20, Nos. 5–6, May–June, 1902, p. 53.

3. Banks and trust companies must report on call at least every three months. Formerly they reported twice a year on specified dates.

4. State superintendent of banks must examine banks and trust companies twice a year instead of annually as heretofore.

5. Directors or three of them must make two examinations of the institution, one in April and the other in October of each year. Report of the examination must be filed with the state banking department. In this examination the directors are to ascertain especially the character of the loans and the security therefor.

6. Not over 10 per cent. of the capital and surplus may be loaned to any one person, firm or corporation, if unsecured, and not over 40 per cent. if secured.[1]

The greatest cause of bank failures is excessive loans to an individual, firm, or corporation in which the officers of the bank or trust company are interested. The provision of law limiting the amount that may be loaned to a single firm is most difficult to enforce. President Hamilton of the American Bankers' Association says the old law limiting the amount of loans by national banks to an individual, firm or corporation was constantly violated.[2] This law provided that 10 per cent. of the unimpaired capital might be so loaned. Under the new law passed at the last session of Congress the limit is 10 per cent. of the unimpaired capital and surplus. The only way of enforcing this act is by suit to forfeit the bank's charter. This remedy has always proved too violent; the examiners and the controller have not had the courage to enforce it, and it has remained a dead letter.

After all, it should be remembered that thoroughly effective bank supervision is well nigh impossible. No matter how acute the examiner, he may be deceived. No outside examination of a bank can supply honesty and good judgment for the officers. We should enact such legislation as will keep the business of banking upon a high plane and make it a calling that will attract only men of honor and integrity. In this way the banker can render his greatest service to society and in an increasing degree set in motion one of the strongest forces making for industrial progress.

[1] "Report of Supt. of Banks, New York," *Bankers' Magazine*, Vol. LXXII, pp. 105–106, 1906.

[2] *Bankers' Magazine*, New York, Vol. LXXII, p. 95, 1906.

THE TERRITORY OF COLORADO[1]

By Frederic L. Paxson

It is commonly taken for granted that the Kansas-Nebraska legislation of 1854 settled the territorial question in the United States, and that the territorial question itself was only a single phase of the larger question of slavery. The tyranny of the slavery problem over the historical mind has completely subordinated the problem of the expansion of the agricultural West, the settlement of new areas, and the providing of adequate institutions of government for the citizens of the frontier. The erection of the territory of Colorado in 1861 is itself proof that slavery was not in its own day destructive of interest in all other topics, however it may have impeded their consideration, and is an illuminative precedent in showing the manner in which territorial problems have been forced upon Congress and ultimately adjusted.

The acquisition of the southwest at the treaty of Guadalupe-Hidalgo in 1848 extended the legal frontier of the United States far beyond the frontier of actual settlement and compelled Congress to give serious thought to the subdivision of large and relatively uninhabited areas of public lands. The act of May 30, 1854, which has commonly been misunderstood as saying the last important word upon the territorial question, merely marked the end of the earliest period of preliminary adjustment. The residuum of the Louisiana purchase and the lands acquired through the Mexican War were at last distributed among two states, California and Texas, and four territories. The two territorial organizations of New Mexico and Utah covered the whole area between California and the Rocky Mountains, while the fortieth parallel divided most of the unorganized area east of the mountains into Kansas and Nebraska territories.

The distribution in effect at the end of the session of 1854 was only preliminary, and within three years Congress had begun to consider the division of three of these territories, Nebraska, Utah, and New Mexico,

[1] Reprinted from *The American Historical Review*, Vol. XII, No. 1, Oct., 1906, pp. 53–65.

whose gigantic size precluded the rigorous execution of law by single territorial establishments. In the first session of the Thirty-fifth Congress, 1857–1858, it was finally proposed to divide two of these territories, creating Arizona in the western end of New Mexico and Nevada in the western end of Utah,[1] while the next session brought a bill to erect Dakota in the northern end of Nebraska.[2] The division was required by various facts of population and migration. The location of the great Pacific trails, the discovery of silver-mines, the willingness to restrict the territory of the Mormons, all appear as inspiring a further subdivision of the scantily populated West.

The Congress of 1857–1858 passed no laws for the erection of new territories in the areas marked out in the debates. There is some internal evidence throughout these and later debates that the young sponsors of the new Republican party were interested in territorial development as a means of continuing the antislavery argument which all parties had agreed in 1854 to forget. But whatever may have been the motives underlying the agitation, the arguments make entirely clear the facts that the boundaries of 1854 were only temporary and that the great, shapeless territories must some day be divided. The session of 1857–1858 contented itself with the suggestion of two new territories of Nevada and Arizona; when the same Congress met for its second session in 1858–1859, two more new territorial projects, those of Dakota and Jefferson, had been added to its list.

In the migrations to the far West, beginning to be heavy in the forties, the two principal routes had branched from the Missouri River near its northern bend on the western boundary of the state of Missouri. From this point the northern or Oregon route had run westwardly along the Platte, the southern or Santa Fé route along the Arkansas. And at the one hundred and second meridian the two trails were already two hundred and fifty miles apart, and were deviating still further to the northwest and southwest respectively.[3] The angle between the trails covered the

[1] *Congressional Globe*, 35 Cong., 1 Sess., pp. 62, 2090.

[2] *Congressional Globe*, December 21, 1858, p. 159.

[3] An act of Congress of May 19, 1846, provided for the erection of forts along the Oregon route. Fort Kearney was established on the Platte 310 miles west of Fort Leavenworth, and Fort Laramie 337 miles beyond Fort Kearney, in 1848. *Ex. Doc. 5*, 31 Cong., 1 Sess., Serial 569, pp. 94, 225. Fort Kearney became the most important post in the northern route and was not abandoned until 1871. *House Ex.*

heart of the "great American desert," which Major Long had described in 1820 as utterly uninhabitable for man, and which men had since 1820 been willing to take at the word of the explorer. It was this uninviting, uninhabited area which in the fall of 1858 appeared before Congress. It demanded not a slicing-up of existing great territories, but a new grouping of lands taken out of the crest of the Rockies and in part from every one of the territories of the central and south West. To this area those who advocated the new project gave the name of the Territory of Jefferson.

Since the discovery of gold in California and the rush of the forty-niners along the overland trails there had always been bodies of prospectors scattered over the mountain region. Rumors of gold discoveries in the desert triangle had been heard early in the fifties, while the panic of 1857 sent fresh bands of men to try their luck in the great game. In the year 1858 numerous parties were exploring the lands between the Arkansas and the Platte, and the arrival at Omaha on January 5, 1859,[1] of several quills filled with gold-dust proved to the Missouri settlers that success had rewarded the prolonged search, and started a new westward movement of large proportions to the Pike's Peak country.

The city of Denver, named for the governor of Kansas territory, became the settlement around which the Pike's Peak country grouped itself in the winter of 1858–1859. Boulder and Golden, Colorado City and Pueblo became secondary centers, each situated as Denver was, at a point from which trade and travel branched from the great trails and entered the valleys leading to the mining-camps.[2]

As early as June, 1858, the forks of the South Platte and Cherry Creek were being examined by prospectors. As the summer and fall advanced more adventurers appeared; the names of Montana, Highland, Auraria, and St. Charles came to designate settlements in the vicinity of the forks; and by November the inclusive name of Denver was heard.[3]

Doc. 12, 43 Cong., 2 Sess., Serial 1164. Lieutenant-Colonel William Gilpin was on July 20, 1847, detailed to a station near the crossing of the Arkansas to keep the peace along the Sante Fé trail. *Ex. Doc. 1*, 30 Cong., 1 Sess., pp. 136, 139.

[1] *Transactions and Reports of the Nebraska State Historical Society*, II. 315. One of the men mentioned as bringing the gold, Albert B. Steinberger, was elected a delegate to Congress by the Auraria meeting of November 6, 1858. He deserted his mission and never reached Washington. His later romantic career in a Pacific kingdom is described in *House Ex. Doc. 161*, 44 Cong., 1 Sess., Serial 1691, 125 pp.

[2] An old military trail connecting Fort Union and Fort Laramie ran through some and within easy distance of all these towns. Jerome C. Smiley, *History of Denver* (Denver, 1901), 229.

[3] The best detailed account of these earliest settlements is found *ibid.*, 200 *et seq.*

In a governmental way the new camp of Denver was situated in Arapahoe County, Kansas. But Arapahoe County had never been organized, and remained only a name until after the legislature of Kansas abolished it in February, 1859.[1] The settlers themselves saw from the start that the five hundred miles of trail between the diggings and the territorial capital forbade protection from, as well as interference by, that government, and that their political salvation lay nearer home. They saw that four territorial governments were involved in the Pike's Peak country, and that the country was in itself an economic unit. It was this understanding which pressed upon Congress early in 1859 with a new territorial scheme, and which even earlier than this had produced a spontaneous political activity in the mountain camps.

The beginnings of Colorado politics are to be found in the movement originating in Denver in November, 1858, and culminating in the territorial organization of Jefferson in November, 1859. The origin seems to have been in a typical early snowfall that drove the miners into their bins in November, 1858, and by enforcing idleness upon them gave an opportunity for talking politics.[2] Perhaps two hundred miners were in Denver when the snowfall came, of whom some thirty-five attended a meeting on November 6, and determined to erect a new government for the Pike's Peak country. "Just to think," wrote one of them, "that within two weeks of the arrival of a few dozen Americans in a wilderness, they set to work to elect a Delegate to the United States Congress, and ask to be set apart as a new territory! But we are of a fast race and in a fast age and must prod along."[3] To secure an attention to their demand they chose one Hiram J. Graham to appear in their behalf at Washington, and one A. J. Smith to represent them in the legislature of Kansas.[4] The arrival of these men in Omaha seems at once to have confirmed

[1] Helen G. Gill, "The Establishment of Counties in Kansas," *Kansas Historical Collections*, VIII. 452.

[2] Ovando J. Hollister, *Mines of Colorado* (Springfield, Mass., 1867), 17, is responsible for the statement that ten inches of snow fell on October 31, 1858.

[3] *Ibid.*, 18.

[4] *Ibid.*, 90; Smiley, 305, 530; Frank Fossett, *Colorado: a Historical, Descriptive, and Statistical Work on the Rocky Mountain Gold and Silver Mining Region* (Denver, 1876), 17; Frank Hall, *History of the State of Colorado* (Chicago, 1889–1895, 4 vols.), I. 208; H. H. Bancroft, *History of the Pacific States*, Vol. XX., *Nevada, Colorado, and Wyoming* (San Francisco, 1890), 402.

the report of the discovery of placer gold in the western streams and to have announced the birth of a new center of population. Four months after the first election a new political whim struck Denver camp, and a set of local officers was chosen March 28, 1859, for Arapahoe County, Kansas, in spite of the fact that Kansas had on February 7, 1859, foreseen the coming emigration, reshaped Arapahoe, and cut out of it five new counties of Montana, Oro, El Paso, Fremont, and Broderick.[1] The only significance of this March election, for its officers seem never to have held power, lies in the fact that nearly eight hundred votes were then cast. Already the heavy migration of 1859 had begun to throw its thousands along the trails to Denver. Whether these thousands were sixty or one hundred, no one can tell today; but it is certain that after half or more of them had gone home in disgust there remained in Jefferson nearly thirty thousand settlers to reiterate the demand that Congress provide a government for them and to maintain their provisional territory for the interim.

The mission of Hiram J. Graham to the second session of the Thirty-fifth Congress failed to produce either an enabling or a territorial act. His arrival in Washington in January, 1859, was followed by the appearance of his territorial scheme in the House, when A. J. Stephens introduced a bill for the erection of Jefferson Territory.[2] Grow of Pennsylvania moved to amend the name to Osage, and when it was reported back from the Committee on Territories on February 16, it was tabled without any serious discussion or opposition.[3] The fate that had postponed the erection of new territories in 1858 continued to postpone in 1859 when Jefferson had been added to the list. Slavery debate forbade territorial legislation, and the single scheme which had a real population behind it was left without local or legal government, and was forced to find its way through 1859 until the next session of Congress might perhaps attend to business and provide for it a legal frame.

[1] Smiley, 246, 531; Hall, I. 183; Bancroft, 402; Baskin and Co., *History of the City of Denver, Arapahoe County, and Colorado* (Chicago, 1880), 187.

[2] His petition was presented in the Senate on January 27. *Cong. Globe*, 35 Cong., 2 Sess., p. 621. Stephens reported bills in the House for Dakota, Arizona, and Jefferson territories on January 28, 1859. *Ibid.*, 657.

[3] *Ibid.*, 1065.

The migration of 1859 multiplied the population of Denver many times and increased the need for orderly government as well by the character as by the number of its inhabitants. A knowledge that no aid from Congress could be had for at least a year revived the local movement until it induced a group of pioneers to hold a caucus, with William Larimer in the chair, on April 11, to consider the local situation.[1] As a result of this caucus a call issued for a convention of representatives of the neighboring mining-camps to meet in the same place four days later. And on April 15, 1859, the camps of Fountain City, El Dorado and El Paso, Arapahoe, Auraria, and Denver met through their delegates, "being fully impressed with the belief, from early and recent precedents, of the power and benefits and duty of self-government," and feeling an imperative necessity "for an immediate and adequate government, for the large population now here and soon to be among us . . . . and also believing that a territorial government is not such as our large and peculiarly situated population demands."[2]

The deliberations thus informally started ended in a formal call for a constitutional convention to meet in Denver on the first Monday in June for the purpose, as an address to the people stated, of framing a constitution for a new "State of Jefferson." "Shall it be," the address demanded, "the government of the knife and the revolver, or shall we unite in forming here in our golden country, among the ravines and gulches of the Rocky Mountains, and the fertile valleys of the Arkansas and the Platte, a new and independent State?"[3] With a generosity characteristic of the frontier the convention determined the boundaries of the prospective state as the one hundred and second and one hundred and tenth meridians of longitude, and the thirty-seventh and forty-third parallels of latitude—an area including, in addition to the present state of Colorado, large portions of Utah and Nebraska and nearly half of Wyoming. The arrival in Denver, a week after this convention, of

[1] Hall, I. 184; Smiley, 306; Bancroft, 403.

[2] The first issue of the *Rocky Mountain News*, April 23, 1859, contains an account of these meetings and texts of the resolutions and addresses. The newspaper at once becomes an invaluable source. Smiley, 306–309.

[3] The address was drawn by a committee of five, and was printed in the *Rocky Mountain News*, May 7, 1859. Smiley, 309.

William N. Byers was important in that it brought an active advocate of statehood into the field, and produced on April 23 the first number of the *Rocky Mountain News*.[1]

When the statehood convention, called on April 15, met in Denver on June 6, the time was inopportune for concluding the movement, for large numbers of the pioneers who had rushed out over the plains for "Pike's Peak or Bust" were already on their disconsolate way back, "busted." The first reputation of the diggings was based upon light and exaggerated discoveries of placer gold; when productive lodes came into view they called for more capital and experience than most of the early prospectors possessed.[2] The height of the gold boom was over by June, and the return migration made it somewhat doubtful whether any permanent population would be left in the country to need a state. So the convention met on June 6, appointed some eight drafting committees, and adjourned, to await developments, until August 1.[3] But by the first of August a line had been drawn between the confident and the discouraged elements in the population, and for six days the convention worked upon the question of statehood. As to permanency, there was by this time no doubt; but the body divided into two nearly equal groups, one advocating immediate statehood, the other shrinking from the heavy taxation incident to a state establishment and so preferring a territorial government with a federal treasury to meet the bills. The body, too badly split to reach a conclusion itself, compromised by preparing the way for either development and leaving the choice to public vote. A state constitution was drawn up on one hand,[4] while, on the other, was prepared a memorial to Congress praying for a terri-

[1] The State Historical and Natural History Society of Colorado has in its collection a file of the *Rocky Mountain News* which is substantially complete, and which has been used in the preparation of this paper. Byers reached Denver April 21 with his printing outfit. He had prepared for prompt issue by printing in Omaha two pages of his first four-page sheet. But even thus the honor of the first issue in Colorado is contested by John L. Merrick's *Cherry Creek Pioneer*. Both papers appeared first on April 23, 1859, Merrick's first being also his last, for Byers at once bought him out and gained control of the field for himself. SMILEY, 247, 248; HALL, I. 184; BANCROFT, 527, has a useful note upon Colorado journalism.

[2] Horace Greeley visited Denver, arriving June 6, 1859. HORACE GREELEY, *An Overland Journey, from New York to San Francisco, in the Summer of 1859* (New York, 1860), 137.

[3] SMILEY, 277; HALL, I. 208; BANCROFT, 404, gives a list of officers; *Rocky Mountain News*, June 11, 1859.

[4] BYERS, in an editorial, *ibid.*, July 23, had supported the statehood argument by reference to the admission clause in the Louisiana treaty of 1803.

torial government;[1] and both documents were submitted to a vote on September 5, 1859, when the memorial was chosen instead of the constitution.[2] Upon October 3 another election was held, pursuant to the memorial, and a delegate to Congress was chosen in the person of Beverly D. Williams, who was local agent of a new Leavenworth and Pike's Peak Express Company which had run its first coach into Denver in May,[3] and whose zeal for mail contracts may have inspired some of his earnestness for congressional countenance.

The adoption of the territorial memorial failed to meet the need for immediate government or to prevent the advocates of such government from working out a provisional arrangement pending the action of Congress. These advocates held a mass-meeting in Denver on September 24,[4] while on the day that Williams was elected to Congress, October 3, they also elected delegates for a preliminary territorial constitutional convention, and upon October 10 this convention met. "Here we go," commented Byers, "a regular triple-headed government machine; south of 40 deg., we hang on to the skirts of Kansas; north of 40 deg., to those of Nebraska; straddling the line, we have just elected a Delegate to the United States Congress from the 'Territory of Jefferson,' and ere long, we will have in full blast a provisional government of Rocky Mountain growth and manufacture."[5] In this convention of October 10, 1859, the name of Jefferson was retained for the new territory, the boundaries of April 15 were retained, and a government similar to the highest type of territorial establishment was provided for.[6] If the convention had met pursuant to an enabling act, its career could not have been more dignified. It adopted a constitution with little trouble, and then dissolved after calling an election for territorial officers for October 24, 1859. The election of this day seems to have been orderly and generally participated

[1] The *Rocky Mountain News* printed on August 6 the journal of the convention; on August 13 the constitution; and on August 20 the memorial.

[2] Smiley, 311; *Rocky Mountain News*, September 17, reports the vote.

[3] Smiley, 251; Alice Polk Hill, *Tales of the Colorado Pioneers* (Denver, 1884), 41; Alexander Majors, *Seventy Years on the Frontier* (Chicago and New York, 1893), 165, 228; Majors was a member of the great freighting firm of Russell, Majors, and Waddell, which was ultimately wrecked when the "Pony Express," which had been started in April, 1860, collapsed.

[4] *Rocky Mountain News*, September 29; Smiley, 312.

[5] *Rocky Mountain News*, October 6.

[6] Hollister, 92; Smiley, 314; Bancroft, 406; text in *Rocky Mountain News*, October 20.

in, for the need of government was obvious. It resulted in the choice of a legislature and an executive staff headed by Governor Robert W. Steele of Ohio.[1] Two weeks later Steele met his assembly and delivered his first inaugural address.

The territory of Jefferson, which thus came into existence on November 7, 1859, is one of the most illuminating incidents in the history of the American frontier. From the days of the State of Franklin[2] the frontiersman has always resented his isolation, and upon receiving evidence of governmental neglect has always been ready to erect his own government and care for himself in a political way. There are many incidents in the history of statehood movements in which settlement has rushed forward more rapidly than legal institutions, with results in the erection of illegitimate provisional governments. But none of these illegitimate governments has been erected more deliberately or conducted with more propriety than this territory of Jefferson. The fundamental principle of American government which Byers expresses is applicable at all times in similar situations:

> We claim [he wrote in his *Rocky Mountain News*] that any body, or community 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 protecting 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.[3]

And the life of the spontaneous commonwealth thus called into existence is a creditable witness to the American instinct for orderly government.[4]

When Congress met in December, 1859, the provisional territory of Jefferson was in operation, while its delegates were in Washington pressing the need for governmental action. One of the agents, B. D. Williams,

[1] Binckley and Hartwell, *Southern Colorado* (Canon City, 1879), 5; Smiley, 315.

[2] George Henry Alden, "The State of Franklin," in *American Historical Review*, VIII. 271–89; see also the Clarksville (Indiana) Resolves, *ibid.*, II. 691–93.

[3] *Rocky Mountain News*, January 4, 1860.

[4] F. L. Paxson, "The Territory of Jefferson; a Spontaneous Commonwealth," in *University of Colorado Studies*, III. 15–18.

was elected on October 3, 1859;[1] the other, George M. Willing,[2] claimed to be the regular choice at this election, and, though apparently not recognized at Washington, reiterated the arguments of Williams and the territorial memorials. Both houses of Congress gave some heed to the facts thus presented. They received from President Buchanan on February 20, 1860, a message transmitting the petition from the Pike's Peak country,[3] and bills to meet the demand were at least introduced into each house. The Senate upon April 3 received a report from the Committee on Territories introducing Senate Bill No. 366, for the erection of Colorado territory;[4] while Grow of Pennsylvania reported to the House on May 10 a bill to erect in the same region a territory of Idaho.[5] The name of Jefferson disappeared from the project in the spring of 1860, its place being taken by sundry other names for the same mountain area. Several weeks in the spring were given in part to debates over this Colorado-Idaho scheme as well as to the older Dakota, Nevada, and Arizona territories. As in the past sessions of Congress, the debate was less upon the need for the erection of several territorial governments than upon the attitude which any bills should take upon the slavery issue. In the demands of the Republican leaders in the territorial debates from 1858 to 1867 can be measured the advance of antislavery attitude, from exclusion of slaves through guarantees to free negroes, and up to the abolition of the "white" clause in the franchise qualification. This obsession of Congress by the slavery debate precluded territorial legislation in the years 1859 and 1860, but the session ended with the reasonableness of one of the demands well presented. In a secondary way the governmental argument was strengthened by petitions for the service of the mails, for post-roads from Fort Laramie to Golden City and from

[1] A memorial of January 4, 1860, describes this election. *House Misc. Doc. 10*, 36 Cong., 1 Sess., Serial 1063, p. 7. The text of his certificate of election is in *Rocky Mountain News*, August 29, 1860.

[2] Two letters written by Willing to Lewis Cass, Secretary of State, are in the Department of State, Bureau of Rolls and Library, in a volume of territorial papers marked, Minn., Neb., Ore., Wyom., Col. D. C., Kan., Mich., Miscellaneous, and are brought to the writer's attention through the courtesy of W. G. Leland, Esq., of the Carnegie Institution, Department of Historical Research.

[3] Richardson, *Messages and Papers of the Presidents*, V. 580; *Sen. Ex. Doc. 15*, 36 Cong., 1 Sess., Serial 1027; *Cong. Globe*, 36 Cong., 1 Sess., p. 841, February 20, 1860; p. 871, February 23.

[4] *Ibid.*, 1502.

[5] *Ibid.*, 2047, 2066, 2077. The memorials of Williams had been presented in the House by Green Adams of Kentucky, on February 15. See under that date *ibid.*, 789; *House Journal*, Serial 1041, 283.

Atchison to Denver. And though on May 12 all of the territorial bills were tabled for the session,[1] the need for them was clearer than it had been at any time since the passage of the Kansas-Nebraska Bill in 1854.

The territory of Jefferson, as organized in November, 1859, had been from the first recognized as merely a temporary expedient. The movement for it had gained weight in the summer of that year from the probability that it need not be maintained for many months. When Congress, however, failed in the ensuing session of 1859–1860 to grant the relief for which the pioneers prayed, the wisdom of continuing for another year the life of a government admitted to be illegal came into question. The first session of its legislature had lasted from November 7, 1859,[2] to January 25, 1860. It had passed comprehensive laws[3] for the regulation of titles in lands, water, and mines, and had adopted civil and criminal codes. Its courts had been established and had operated with some show of authority. But the services and obedience to the government had been voluntary, no funds being on hand for the payment of salaries and expenses. One of the pioneers from Vermont wrote home, "There is no hopes [*sic*] of perfect quiet in our governmental matters until we are securely under the wing of our National Eagle." In his proclamation calling the second election Governor Steele announced that "all persons who expect to be elected to any of the above offices should bear in mind that there will be no salaries or per diem allowed from this territory, but that the General Government will be memorialized to aid us in our adversity."[5] Upon this question of revenue it was that the territory of Jefferson was wrecked. Taxes could not be collected, since citizens had only to plead grave doubts as to the legality to evade payment. "We have tried a Provisional Government, and how has it worked?" asked William Larimer in announcing his candidacy for the office of territorial

[1] *Cong. Globe*, 36 Cong., 1 Sess., 2079–2085.

[2] The *Rocky Mountain News* had the text of Steele's message in its issue of November 10, 1859. It is also found in *House Misc. Doc. 10*, 36 Cong., 1 Sess., Serial 1063, pp. 11–15.

[3] *Provisional Laws and Joint Resolutions Passed at the First and Called Sessions of the General Assembly of Jefferson Territory, Held at Denver City, J. T., November and December, 1859, and January, 1860. Published by Authority* (Omaha, N. T., Robinson and Clark, 1860, pp. 298). The writer knows of the existence of only two copies of this pamphlet.

[4] *Early Day Letters from America (now Denver) Written by Libeus Barney to the Bennington Banner, Bennington, Vermont, 1859–1860* (Denver?, n. d., pp. 88), 54.

[5] Proclamation of September 18, in *Rocky Mountain News*, September 19, 1860.

delegate. "It did well enough until an attempt was made to tax the people to support it."[1] More than this, the real need for the government became less apparent as 1860 advanced, for the scattered communities learned how to obtain a reasonable peace without it. American mining-camps are peculiarly free from the need for superimposed government. The new camp at once organizes itself on a democratic basis, and in mass-meeting registers claims, hears and decides suits, and administers summary justice. Since the Pike's Peak country was only a group of mining-camps, there proved to be little immediate need for central government, for in the local mining-district organizations all of the immediate needs of the communities could be satisfied. So loyalty to the territory of Jefferson, in the districts outside Denver, waned during 1860, and by the summer of that year its moral influence had virtually disappeared. Its administration held together, however. Governor Steele made efforts to rehabilitate its authority, holding an election on October 22, 1860, to choose a second legislature.[2] On November 12 he met his second assembly, he himself having been re-elected by a trifling vote, to continue the tradition of the territory. From November 12 to November 27 it sat at Denver; then until December 7 it continued its sessions at Golden. And upon this last day it dissolved itself forever.[3]

When the Thirty-sixth Congress met for its second session in December 1860, the Jefferson organization was in the second year of its life, yet in Congress there was no more immediate prospect of territorial action than there had been since 1857. Indeed, the election of Lincoln brought out the eloquence of the slavery question with a renewed vigor that monopolized the time and strength of Congress until the end of January. And had not the departure of the southern members to their states cleared the way for action, it is highly improbable that even this session would have produced results of importance.

Grow had announced in the House on December 12, 1860, a general territorial platform similar to that which had been under debate for three

[1] Letter of August 21, *ibid.*, August 22, 1860.

[2] BANCROFT, 410; SMILEY, 321; HALL, I. 249.

[3] HOLLISTER, 123.

years.[1] Until the close of January the southern valedictories held the floor, but at last the admission of Kansas on January 29, 1861, revealed the fact that pro-slavery opposition had departed and that the long-deferred territorial scheme could have a fair chance.[2] On the very day after Kansas was admitted, with its western boundary at the twenty-fifth meridian from Washington, the Senate revived its Bill No. 366 of the last session and took up its deliberation upon a territory for Pike's Peak.[3] Only by chance did the name Colorado remain attached to the bill. Idaho was at one time substituted for Colorado, but was amended out in favor of the original name on February 4 as the bill passed the Senate.[4] The boundaries were materially cut down from those which the territory had provided for itself. Two degrees were at once taken from the north of the territory, and after some hesitation over the Green River the western boundary was placed at the thirty-second meridian from Washington. In this shape, between the thirty-seventh and forty-first parallels, and the twenty-fifth and thirty-second meridians, the bill passed the Senate on February 4, the House on February 18, and received the signature of President Buchanan on February 28.[6] The absence of serious debate in the passage of this Colorado act is excellent evidence of the merit of the scheme and the reasons for its being so long deferred.

On February 28, 1861, the territory of Colorado became a legal fact; Buchanan left it to his successor to erect the territorial establishment. President Lincoln, after some delay caused by pressure of business at Washington, commissioned General William Gilpin as first governor of the territory. Gilpin had long known the mountain frontier; he had commanded a detachment on the Santa Fé trail in the forties, and had written prophetic books upon the future of the country to which he was now sent. His loyalty was unquestioned, and his readiness to assume responsibility went so far as perhaps to cease to be a virtue. He arrived in Denver at his new post on May 29, 1861,[7] and within a few days was

[1] *Cong. Globe*, 36 Cong., 2 Sess., p. 81.

[2] Leverett W. Spring, *Kansas* (Boston, 1885), 266.

[3] *Cong. Globe*, 36 Cong., 2 Sess., p. 639.

[4] *Ibid.*, 729.

[5] F. L. Paxson, "The Boundaries of Colorado," in *University of Colorado Studies*, II. 87–94.

[6] *Cong. Globe*, 36 Cong., 2 Sess., pp. 729, 777, 1003, 1206, 1274.

[7] Hall, I. 266; Fossett, 106.

ready to take charge of the territory and to receive from the hands of Governor Steele[1] such authority as remained in the provisional territory of Jefferson.

[1] Steele issued a proclamation recommending the citizens to remain "loyal and true" to the federal government on May 23, *Rocky Mountain News*, May 29, 1861. He handed over the government to Gilpin on June 6. SMILEY, 321, 322.

THE MOLLUSCA OF COLORADO.[1] PART I

By Junius Henderson

When the writer began the study of the molluscan fauna of Colorado a few years ago, the fact that most emphatically and persistently presented itself was the almost total lack of interest in and knowledge of the subject among the biologists of the state. A few conchologists had visited our mountain regions, but the great plains area was untouched except for the visit of Mr. Simpson to the extreme northeastern corner of the state. In response to requests for information, directed to the teachers of various branches of natural history in our public schools and other institutions of learning, it was not at all encouraging constantly to receive the reply that there are no mollusks (or "shell-fish," in popular parlance) in Colorado. However, a few teachers and laymen were found who were sufficiently interested to have collected shells in a modest way and some faithful friends promised to help the work along—promises which have been fulfilled—for such work, to be effective, must be co-operative. If this paper does nothing more than convince teachers and the general public that we have in all parts of the state an interesting and much neglected fauna, it will be worth while.

In addition to this lack of interest, another great difficulty and one which may never be wholly overcome, has arisen from doubts as to the accuracy of identification in many instances in the early reports, some of which doubts cannot now be cleared up. The matter was further complicated by the confusion of species new to science with species theretofore described. The fact that the records are scattered through publications not available in small libraries and that the literature of the subject is in other respects unsatisfactory, tended to discourage local naturalists from undertaking the work which we now feel should be no longer delayed.

A number of lists of Colorado mollusks were long ago published as a result of the efforts of a few collectors, as shown by the bibliography accompanying this sketch, but none of them were at all complete. Inger-

[1] This paper will be followed by one treating the Gastropods.

soll, with the Hayden Survey, Yarrow with the Wheeler Survey and Cockerell working independently were among the early collectors, the latter still continuing his interest, in connection with other branches of natural history.

In view of the abundance of Mollusca in almost every pond, lake, stream, and water-hole of the plains, to find so few published records from the eastern half of the state and that some of our most abundant and two of our largest shells are wholly unrecorded was somewhat surprising. It is worthy of especial note that in the plains area almost our only records of fresh-water species, except the few from Lodge Pole Creek and Ft. Morgan, are confined to the area west of a line drawn from Pueblo to Crow Creek, while about the only land snails reported from east of that line are the *Succinea* collected at Mono, on the eastern boundary of the state. The reason is that local naturalists are not generally interested in conchology and visiting conchologists are usually in haste to reach the mountains.

There is perhaps no part of the state in which a careful search would not reveal both land and fresh-water shells containing the living animals. This paper does not deal with fossil forms except incidentally. The land snails are with a few exceptions quite small, the principal exception being the genus *Oreohelix*. This may account for the fact that they are not well known to teachers of zoology or to the general public. The fresh-water snails average much larger, the *Limnæas* of some species reaching a length of an inch and a half, while several bivalve species reach a length of over three inches. Both land and fresh-water shells are found from the valleys nearly to the top of the range. Almost every pond, lake, or stream will yield some of the latter, while the former may be expected anywhere in damp places under rocks, boards, dead leaves, etc. Generally speaking, they are not apt to be found under resinous trees or among pine needles, but they may sometimes be found even among the pines, in places where there are also quaking aspens and other desiduous trees.[1]

Colorado, because of its great variation in altitude, temperature, humidity, and other conditions, and because of the mountains and other

[1] Compare V. STERKI, "Shells in Pine Forests," *The Nautilus*, Vol. V 1891–92, p. 118.

supposed barriers, is considered an important field for extensive and intensive collecting and study of mollusks. Up to the present time the study of the influence of altitude upon mollusks in this region has given chiefly negative results. Instead of dwarfing the species as in Montana and other regions where the cold of high altitudes is more intense,[1] the higher altitudes seem more favorable to land snails than lower levels, because of increased humidity. The finest specimens of *Oreohelix strigosa* and *Vitrina alaskana* found have been at 11,000 and 9,300 feet respectively. Ingersoll[2] reports the same fact concerning *Thysanophora* (*Microphysa*). On the other hand, the larger fresh-water snails we have found do not occur in the lakes at timber line at all. Among bivalves we have found *Pisidia* at 11,000 feet, *Calyculina* at 8,500 feet, but no *Unionidæ* at all in the mountains or anywhere in the western half of the state. The only thick-shelled *Unionidæ* found in the state are those from Lodge Pole Creek and Las Animas County, though a thin-shelled species (*Strophitus edentulus pavonius*) is found close to the foothills.

The majority of our species, both land and fresh water, are also found in the Mississippi Valley and eastward, probably having reached Colorado from the eastward or northward, but, on the other hand, there is an impressive and probably significant absence of such genera as *Polygyra*, *Campeloma*, *Viviparus*, *Goniobasis* and *Pleurocera*, which are so well represented in the eastern states. The distribution of *Oreohelix* and *Thysanophora* indicates that they have crossed the mountains from the westward; but if so, the former must have arrived at the base of the foothills long ago, as suggested by fossil specimens in the Quaternary deposits. *Viviparus*, *Campeloma* and *Goniobasis* lived in northeastern Colorado, together with *Anodonta*, *Unio*, and *Physa*, during the latter part of Cretaceous time, as shown by the Laramie fossils of Crow Creek and neighboring localities, but the three first-named genera have disappeared from the state, while *Physa* is among our most abundant mollusks at the present time. *Anodonta* is reported from Lodge Pole Creek, its near relative *Strophitus* is our most common large bivalve, and *Unio* has been found in two localities. *Lymnæa*, *Planorbis*, and *Unio* occur in Jurassic strata

[1] Morton J. Elrod, *Bull. Univ. Mont.*, No. 17, p. 259.

[2] *Eighth Ann. Rept. Hayden Survey*, p. 398.

near Canyon City, but, owing to the absence of fresh-water beds from most of the Cretaceous formations, they are not found between the Jurassic and Laramie. The Jurassic *Unios* are not of distinctively North American type. *Omphalina?*, *Lymnæa*, *Planorbis* and *Sphærium* are found in the Tertiary lake beds of Florissant.[4] The three last-named genera are still represented in the state by living species.

This attempt to incorporate into one paper the published records of our Mollusca, together with new records based upon recent collections, must necessarily be more or less incomplete and in some respects inaccurate, because of the present unsatisfactory *status* of some nominal western species, the impossibility of now certainly determining the accuracy of identification of early collections and the inaccessibility of some important publications which might furnish further records or other information. However, it is hoped that this bringing-together in brief form of the numerous records must at least greatly aid in future investigations, and afford a fresh starting-point from which our molluscan fauna may be attacked with renewed vigor, besides presenting the additional records for the first time given to the public. It is quite possible that some published records have been overlooked.

The writer is very grateful to Dr. Henry A. Pilsbry and Mr. E. G. Vanatta, of the Academy of Natural Sciences of Philadelphia; Dr. Paul Bartsch, of the U. S. National Museum; Mr. Frank C. Baker, of the Chicago Academy of Sciences; Dr. V. Sterki, of New Philadelphia, Ohio; Professor T. D. A. Cockerell, of the University of Colorado; Mr. Chas. T. Simpson, of Lemon City, Florida; and Mr. Bryant Walker, of Detroit, Michigan, for their kindly assistance in the identification of difficult material, for reading and revising portions of the manuscript, for additional records they have furnished and for many suggestions for the improvement of the paper in various ways; also to those whose names are mentioned in the catalogue for the collections they have so kindly brought in from various parts of the state. The records from Mr. Vanatta's manuscript are based upon specimens in the collection of the Academy of Natural Sciences of Philadelphia. Further collections,

[4] COCKERELL, "The Fossil Mollusca of Florissant, Colorado," *Bull. Amer. Mus. Nat. Hist.*, Vol. XXII, Art. XXVII, pp. 459–462, 1906.

data, suggestions, or corrections are invited from any who are interested in the subject, in order that errors may be corrected or omissions supplied in a supplemental paper if deemed advisable.

In the catalogue the figures in bold-faced type indicate the numbers of the several publications in the bibliography, the light-faced figures indicating the pages. The illustrations, except Plates I and II, are electrotyped from originals used in publications of the Smithsonian Institution, by courtesy of the authorities of that institution.

The following species and subspecies are herein recorded for the first time from this state, so far as we have ascertained: *Strophitus edentulus pavonius, Unio tetralasmus camptodon, Calyculina securis, Pisidium noveboracense, P. compressum, Oreohelix strigosa albofasciata, O. haydeni, Pupilla sonorana, Bifidaria armifera, Vertigo ventricosa elatior, Vallonia gracilicosta, Helicodiscus eigenmanni arizonensis, Succinea salleana, S. haydeni, Lymnæa bulimoides techella, L. caperata, Planorbis exacuous, Ancylus caurinus, Physa integer, P. anatina, P. lordi, P. hawnii ?.*

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LIST OF LOCALITIES

[In order to avoid designating the portion of the state in which the various stations are located in each instance, this table is presented]

Animas Valley, La Plata Co.
Ault, Weld Co.
Baker's Park, Mineral Co.
Bear Canyon, Boulder Co.
Black Lake, Summit Co.
Black Lake Creek, Summit Co. .
Blue River, Summit Co.
Boulder, Boulder Co.
Buzzard Creek, Mesa Co.
Canyon City, Fremont Co.
Carrizo Creek, Las Animas Co.
Cattle Creek, Garfield Co.
Chalk Creek, Chaffee Co.
Clear Water Creek, Mesa Co.
Clear Creek, Mineral Co.
Cottonwood Gulch, Saguache Co.
Cotapaxi, Fremont Co.
Craig, Routt Co.
Crow Creek, Weld Co.
Cunningham Gulch, San Juan Co.
Davidson's Ranch, Boulder Co.
Del Norte, Rio Grand Co.

Dillon, Summit Co.
Divide Creek, Garfield Co.
Eagle River, Eagle Co.
Egeria, Routt Co.
Eldora, Boulder Co.
Empire, Clear Creek Co.
Estes Park, Larimer Co.
Fairplay, Park Co.
Florence, Fremont Co.
Florissant, Teller Co.
Ft. Collins, Larimer Co.
Gault, Weld Co.
Gleneyre, Laramie Co.
Glenwood Springs, Garfield Co.
Granby, Larimer Co., N. of Grand Lake.
Grand Mesa, Mesa Co.
Greeley, Weld Co.
Hardscrabble Canyon, Custer Co.
Horseshoe Bend Gulch, Custer Co.
Hot Sulphur Springs, Grand Co.
Howardsville, San Juan Co.
Hygiene, Boulder Co.
Kremmling, Grand Co.
Lake George, W. of Florissant.
Lake of the Clouds, Custer Co.
Little Blue Creek Gunnison Co.
Lodge Pole Creek, Logan Co.
Los Pinos River, La Plata Co.
Lyons, Boulder Co.
Micawber Mine, Custer Co.
Magnolia, Boulder Co.
Mam Mts., Mesa Co.
Meeker, Rio Blanco Co.
Mineral Creek, Mineral Co.
Monon, Baca Co.
Muddy Creek, Grand Co.
Naomi, Summit Co.
Northrop, Chaffee Co.
North Mam Creek, Garfield Co.
Owen's Lake, Boulder Co.
Plateau Creek, Mesa Co.
Pottery Pass, Summit Co.
Powderhorn, Gunnison Co.
Red Cliff, Eagle Co.
Rio La Plata, La Plata Co.
Roaring Fork, Garfield Co.
Rock Creek, Routt Co.
Round Mt., Custer Co.
Saguache Creek, Saguache Co.
Salida, Chaffee Co.
St. Mary's Lake, Mineral Co.
St. Vrain Canyon, Boulder Co.
Short Creek, Custer Co.
Slate Creek, Summit Co.
Squaw Creek, Eagle Co.
Straight Creek, Summit Co.
Surface Creek, Delta Co.
Swift Creek, Custer Co.
Twin Lakes, Lake Co.
Twin Mesa, Gunnison Co.
Two Elk Creek, Eagle Co.
Wales Canyon, Pueblo Co.
Ward, Boulder Co.
Wellsville, Custer Co.
West Cliff, Custer Co.
West Ten Mile Creek, Summit Co.
Wet Mt. Valley, Custer Co.
Wheeler, Summit Co.
White Earth Creek, Gunnison Co.
Williams Canyon, El Paso Co.
Willow Creek, Custer Co.
Windsor, Weld Co.
Zion Peak, Lake Co.

Systematic Table of Colorado Molluscan Genera

CLASS PELECYPODA (*Bivalves*)

Order Prionodesmacea
  Superfamily Naiadacea
    Family Unionidæ
      Genera *Anodonta*, 1 sp.
        Strophitus, 1 sp.
        Anodontoides, 1 sp.
        Lampsilis, 3 sp.
        Unio, 1 sp.

Order Teleodesmacea
    Superfamily Cyrenacea
        Family Sphæriidæ
            Genera *Sphærium*, 4 sp.
                Calyculina, 3 sp.
                Pisidium, 5 sp.

CLASS GASTROPODA (*Univalves*)

Subclass ANISOPLEURA

Superorder Euthyneura
    Order Pulmonata
        Suborder Stylommatophora
            Family Helicidæ
                Genera *Oreohelix*, 3 sp. and var.
                    Thysanophora, 1 sp.
                    Polygyra, 1 sp.
            Family Pupillidæ
                Genera *Pupoides*, 2 sp.
                    Pupilla, 3 sp.
                    Bifidaria, 2 sp.
                    Vertigo, 7 sp. & va.
            Family Achatinidæ
                Genus *Cochlicopa*, 1 sp.
            Family Valloniidæ
                Genus *Vallonia*, 3 sp.
            Family Zonitidæ
                Genera *Vitrina*, 1 sp.
                    Vitrea, 1 sp.
                    Euconulus, 1 sp.
                    Zonitoides, 3 sp.
            Family Limacidæ
                Genus *Agriolimax*, 2 sp.
            Family Endodontidæ
                Genera *Pyramidula*, 2 sp.
                    Helicodiscus, 2 sp.
                    Punctum, 1 sp.
                    Sphyradium, 1 sp.
            Family Succineidæ
                Genus *Succinea*, 8 sp.
        Suborder Basommatophora
            Family Limnæidæ
                Genera *Limnæa*, 12 sp. and var
                    Planorbis, 5 sp.
            Family Ancylidæ
                Genus *Ancylus*, 3 sp.
            Family Physidæ
                Genera *Physa*, 11 sp.
                    Aplexa, 1 sp.

Superorder Streptoneura
Order Ctenobranchiata
Suborder Streptodonta
Family Valvatidæ
Genus *Valvata*, 1 sp.

Key to Colorado Mollusca

Inherent difficulties in the description of shells make it almost impossible to formulate a key which is sufficient of itself for the identification of species, but this key may be of assistance to students, who, however, must in the end, depend upon more extended descriptions, in other works. The great majority of our species are described in Baker's *Mollusca of the Chicago Area*, published by the Chicago Academy of Sciences; Binney's "A Manual of American Land Shells," *Bulletin No. 28* of the *United States National Museum*, Binney, Bland and Tryon's "Land and Fresh-Water Shells of North America," Parts I, II, III, and IV, *Smithsonian Miscellaneous Collections*, Nos. 143, 144, 194, and 253, respectively; Prime's "Monograph of American Corbiculidæ." *Smithsonian Miscellaneous Collections*, No. 145.

PELECYPODA (Bivalves)

A. Shell more than 2 inches in length, lateral teeth posterior to cardinal teeth.
- *a.* Rather thin shelled, cardinal teeth slightly or not at all developed.
  1. Coarse wrinkles on beaks in parallel double loop. **Anodonta grandis giganteus**
  2. Coarse parallel wrinkles on beaks, not doubly looped. **Strophitus edentulus pavonius**
  3. In addition to coarse wrinkles, fine ridges on umbones, directed posteriorly. **Anodontoides ferussacianus**
- *b.* Shell solid, cardinal teeth well developed.
  1. Length about twice the height or more.
     - *aa.* Beak wrinkles 5 to 7, in long poorly defined double loop, cardinal teeth double in both valves. **Lampsilis anodontoides**
     - *bb.* Umbones with about 14 fine undulating ridges. **Lampsilis luteola**
     - *cc.* Umbones with 5 to 8 coarse concentric ridges. **Unio tetralasmus camptodon**
  2. Length about $\frac{1}{2}$ greater than height, 6 coarse beak wrinkles not doubly looped, cardinal teeth double only in left valve. **Lampsilis ventricosa**

B. Shell less than one inch in length, lateral teeth both anterior and posterior.
- *a.* Animal with one short siphon; mussel generally small to minute, 1.5 to 8 mm. long, in a few species 8 to 12 mm.; anterior part generally longer than posterior. **Pisidium** spp.
- *b.* Animal with 2 longer siphons, connate at their bases for a longer or shorter distance; mussel averaging larger, 5 to 20 mm. long; anterior part generally shorter than posterior.
  1. Shell and hinge generally stouter, beaks rarely calyculate (capped). **Sphærium** spp.

2. Shell and hinge very slight, beaks in most species calyculate (with caps). **Calyculina** spp.

(After consultation with our best authorities on these three genera it seems best to omit any attempt to put the species in a key, in the present state of knowledge).

GASTROPODA (Univalves)

* Terrestrial Snails, with Well-developed Shell

A. Height of shell less than width.
  a. Width of adults more than 8 mm.
    1. Lip well reflexed. **Polygyra monodon**
    2. Lip not reflexed, whorls 5, marked by one or more dark spiral bands.
      aa. Depressed, sometimes reaching width of 25 mm. and height of 10 mm. **Oreohelix strigosa**
      bb. Smaller with same number of whorls, width 16 mm., height 8 mm., otherwise as *strigosa*. **Oreohelix strigosa concentrata**
      cc. Spire elevated, last whorl descending toward aperture. **Oreohelix strigosa cooperi**
      dd. Similar to *strigosa* but with several riblike revolving lines crossing the lines of growth. **Oreohelix haydeni**
  b. Width less than 8 mm.
    1. Discoidal, apex level with or below top of last whorl.
      aa. Whorls not equally visible above and below, growth lines not crossed by parallel spiral lines, whorls 5 or 6, width 4 mm., height 2.5 mm. **Thysanophora ingersolli**
      bb. Whorls equally visible above and below, growth lines crossed by fine, equidistant, parallel spiral lines, width 3.5 mm., height 1.5 mm. **Helicodiscus parallelus**
      cc. Larger, width 4.5 to 5 mm. **H. eigenmanni arizonensis**
    2. Apex raised more or less above top of last whorl, peristome not everted or reflected.
      aa. Rather depressed.
        1. Thin, brownish horn, smooth, shining, whorls 4, last enlarging very rapidly, width 3.5 to 4 mm. **Vitrea hammonis**
        2. Very fragile, greenish white, transparent, smooth, glassy, whorls 3, last composing most of shell, width 5 mm. **Vitrina alaskana**
        3. Smooth, growth lines fine, requiring a lens, color amber to whitish, whorls 4 or 5, width 5 mm., heighth 3.75 mm., usually smaller. **Zonitoides arboreus**
        4. Minute, spire nearly flat, growth lines strong under lens, color white, width 2.5 mm., height 0.75 mm. **Zonitoides minusculus**
        5. As *minusculus*, except striæ more riblike, interspaces microscopically striate, spire less depressed. **Zonitoides conspectus**

6. Umbilicus wide, exhibiting all volutions from below, striæ riblike, width 5 to 5.75 mm., height 2.5 to 2.75 mm.
Pyramidula cronkhitei anthonyi

7. Shaped as *anthonyi*, but smoother, irregularly wrinkled or ribbed.
Pyramidula cockerelli

8. Minute, reddish or brownish, marked by strong striæ and fine spiral lines, strongest on base, width 1 mm., height, 0.5 mm.
Punctum pygmæum

bb. Elevated, smooth, shining, amber-colored, whorls 6, increasing regularly, umbilicus not perforated or scarcely so, width 2.25 to 3 mm., height 1.75 to 2.75, juveniles easily mistaken for young *Pupa*.
Euconulus trochiformis

3. Minute, umbilicate, depressed, apex raised above top of last whorl, persistome everted or reflected, light unicolored, width 2 to 2.6 mm., height 1 to 1.3 mm.

aa. Rather solid, shining, not ribbed, growth striæ fine, persistome reflected and white. **Vallonia pulchella**

bb. Solid, striæ stronger and more distinct than in *pulchella* and rather irregular, last whorl expanding and descending toward aperture, peristome reflected and porcelain-white. **Vallonia gracilicosta**

cc. Thin, ribs fine and numerous and bearing membranes which give the ribs of fresh specimens a roughly sharp appearance, last whorl expanding and descending toward aperture, persistome everted but not reflected into a decided lip. **Vallonia cyclophorella**

B. Height of shell greater than width.

a. Aperture very large, peristome simple, shell thin and fragile, imperforate, whorls usually 3, increasing rapidly.

1. Long and narrow.

aa. Aperture long and narrow, exhibiting all volutions within to apex, last whorl more than twice size of others combined, pellucid, color light or greenish horn, growth lines minute, height 15 to 20 mm., width 6.5 to 9 mm.
Succinea retusa

bb. Aperture but little more than half length of shell, more nearly circular than in *retusa*, color straw or greenish horn, sometimes with a reddish tinge, shining, whorls 3, height 6 to 12 mm., spire sharp, growth lines minute (our specimens all small, about 5 mm). **Succinea avara**

cc. Pale horn or whitish, spire short and acute, coarsely striate, shining, height 20 mm., width 8 mm., aperture 13 mm., long and widest below middle.
Succinea sillimani

dd. Pale greenish horn-color, striæ coarse and irregular, surface without luster, aperture widest about middle and $\frac{2}{3}$ the length of shell, height of shell 12 mm., width 6 mm., fold of columella distinct. **Succinea rusticana**

ee. Color dull horn, growth lines rude, aperture about $\frac{2}{3}$ length of shell, last whorl constituting nearly whole shell, columella gently curved and without fold, height 13 mm. **Succinea nuttalliana**

ff. Thin, shining, amber-colored, spire short, acute, whorls convex, last marked by growth wrinkles, light callus on columella, aperture $\frac{5}{7}$ length of shell, expanding below and exhibiting volutions to apex, height 15 to 21 mm., width 7 to 9 mm. **Succinea haydeni**

gg. Whitish horn-colored, pellucid, shining, delicately striate, marked irregularly with impressed spiral lines, aperture oval, angular above, height 18 to 20 mm. **Succinea salleana**

2. Wider in proportion to height.

aa. Whorls full and rounded, growth wrinkles irregular, interspaces often crossed by parallel spiral lines. **Succinea grosvenori**

bb. Similar to *avara* but more compact, shorter in proportion to width. **Succinea stretchiana**

b. Aperture $\frac{1}{3}$ length of shell, shell oval, highly polished, whorls 6, gradually increasing in size, growth lines very fine, peristome simple, length 5.5 to 6 mm., width 2.25 mm., an unmistakable species. **Cochlicopa lubrica**

c. Aperture very small, shell small, spire long in proportion to aperture, generally cylindrical with obtusely rounded apex, whorls numerous, not usually increasing much after the first 2 or 3.

1. Whorls 6 or 7, except *B. pentodon.*

aa. Brownish horn color, shell tapering regularly from body whorl to apex, growth lines fine, base produced, aperture toothless, umbilicus deep and open, persistome reflected, height 5 mm., width 2 mm. **Pupoides marginatus**

bb. Horn color, small, cyclindrical, irregularly ribbed, aperture toothless, peristome narrowly reflected and white, umbilicate, umbilicus bounded by an angle, height 3.5 mm., width 1.6 mm. **Pupoides hordaceus**

cc. Dark chestnut or bay, lower 4 whorls about equal diameter, growth lines fine, aperture usually toothless, umbilicus perforate, persistome somewhat reflected, height 4 mm., width 1.5 mm. **Pupilla muscorum**

dd. Light brown, last whorl ascending and rapidly expanding toward aperture, external callus separated from subreflected peristome by deep constriction, teeth obtuse, 1 parietal, 1 columellar, 1 far within base of aperture, height 3 mm., width 1.5 mm. **Pupilla blandi**

ee. Brownish horn color, cylindrical, whorls gradually increasing, striated rugulose, coarser near aperture, lip abruptly but narrowly everted, teeth white, parietal deep seated, long and spiral, columellar perpendicular along columella, palatal (the inferior) strong often with threadlike prolongation inward, height 2.6 mm., width 1.3 mm. **Pupilla sonorana**

ff. Light horn color, inflated, vitreous. shining, smooth, growth lines crowded, first 3 whorls increasing rapidly, last 3 about equal, 1 single or double parietal lamella, a massive tooth on columellar wall far within, 1 at lower

right-hand angle of aperture, 1 above it, sometimes 1 or 2 others, peristome broadly reflected, height 4 to 4.5 mm., width 2.25 mm.
Bifidaria armifera

gg. Whitish, very small, outline as in *armifera*, whorls 5, 8 teeth, 1 on columella, 3 on base, 3 on inner side of lip, a long one extending downward from parietal wall, peristome slightly reflected, height 2 mm., width about 1 mm.
Bifidaria pentodon

hh. Chestnut brown, perforate, middle 3 whorls about equal, last expanding toward base, with tendency to separate from penultimate one, peristome simple, slightly reflected over umbilicus. **Sphyradium edentulum**

2. Whorls 5 or less.

aa. Color dark amber, ovate, whorls 5, increasing somewhat regularly and rapidly, last inflated, peristome somewhat expanded, with groove behind and thickened within, umbilicus expanded, 2 parietal teeth, 1 columellar, 2 basal, 1 inside outer margin of aperture, height 3 mm., width 1.5 mm.
Vertigo ovata

bb. Amber-colored, narrowly ovate, highly polished, whorls 5, one tooth on middle of lower lip, and one on parietal wall, one on columella and a small one within outer lip. **Vertigo tridentata**

cc. Color light chestnut, cylindrical ovate, whorls 4 or 4½, increasing slightly after the second, last about ½ length of shell, umbilicus slightly open, teeth variable, 1 to 3 parietal, 1 columellar, 1 at lower left-hand angle, 2 on oblique base and outer lip, sometimes 1 above and 1 below latter two, peristome thickened but not reflected, width 1 mm. **Vertigo gouldi**

dd. Ovate to oblong ovate, whorls 4, smooth, polished, one parietal tooth, 2 columellar and 2 basal, outer margin of aperture fleunose, peristome reflected. **Vertigo ventricosa elatior**

ee. Shape as in *gouldi*, but last 2 of the 3½ whorls equal, umbilicus distinct, lip reflected, 1 parietal tooth, 1 columellar, 2 well within lip.
Vertigo modesta corpulenta

ff. Much like *corpulenta*, but usually an additional lamella in variable stages of development in the lower left-hand angle of aperture.
Vertigo modesta parietalis

gg. Minute, brown, shining, striate, peristome thick and brown, teeth brown, 1 long parietal tooth, 1 columellar, 2 long lamellæ on outer lip, lower one the larger, height 1.5 mm. **Vertigo coloradensis**

hh. Chestnut brown, shining, whorls 5, upper 3 tapering to blunt apex, last ascending toward aperture as in *Pupilla blandi*, 1 short entering parietal tooth, a smaller one to right and nearer upper angle, a strong entering columellar lamella, 2 long folds within outer lip, lower one the larger, height 2 mm., width 1.1 mm. **Vertigo concinnula**

ii. Very small, color dark chestnut, growth lines minute, angle of convergence toward produced base and blunt apex about equal, whorls 5, 2 projecting parietal teeth, 1 columellar, 1 basal, a long curved one within outer lip, a long entering lamella curving from outer basal angle to behind columella, peristome white, unreflected, umbilicus open, deep, height 1.4 mm., width 0.9 mm. **Vertigo milium**

**** Terrestrial Naked Slugs**

A. Unicolored, unspotted. **Agriolimax campestris** and var.

B. Darker reticulated lines on lighter ground color giving a spotted appearance. **Agriolimax agrestis**

***** Fresh-Water Snails**

A. Discoidal, whorls coiled in one plane.

a. More than 5 mm. in width.

1. Color white to brown, whorls 4, spire flat from above, depressed and showing 2½ to 3 whorls from below, whorls slightly carinate above, width 15 to 20 mm. **Planorbis trivolvis**

2. Distorted form of *trivolvis*, plane of inner whorls inclined to that of outer whorl so that carina of 3d whorl forms a shoulder on right side and sinks beneath outer whorl on left side. **Planorbis plexata**

3. Whorls 3, sharply carinate above and below, conically depressed above and below, smaller than *trivolvis*, V-shaped aperture extending above top of body whorl. **Planorbis bicarinatus**

b. Less than 5 mm. in width.

1. Color bright horn to black, umbilicus wide and shallow, showing all volutions from above and below, apex depressed somewhat below top of last whorl. **Planorbis parvus**

2. Whitish, with deeper, narrower umbilicus than *parvus*, apex not sunken. **Planorbis umbilicatellus**

3. Dark brown, periphery of outer whorl sharply carinate. **Planorbis exacuous**

B. Small, depressed conical, patelliform.

a. Fragile, sides parallel or incurved in middle, apex elevated and curved backward, ⅔ from anterior end of shell, extreme length 4 mm., width 1.1 mm., height 1 mm., usually much smaller. **Ancylus fragilis**

b. Similar to, if not identical with, *fragilis*. **Ancylus caurinus**

c. Pale, thin, delicate, sides nearly straight, not quite parallel, apex sharp, ⅔ from anterior end, turned to right. **Ancylus parallelus**

C. Spire depressed, but apex raised considerably above body whorl, color brownish, shining, whorls 3½, last much deflected, making aperture nearly round and continuous, peristome simple and nearly continuous, easily distinguished from all other Colorado species. **Valvata lewisi**

D. Spire elevated, sinistral.

a. Rather wide in proportion to height, last whorl usually constituting larger part of shell. **Physa** spp.

(Owing to unsatisfactory status of species of this genus it is deemed best not to attempt to differentiate them in this key.)

b. Distinguished from *Physa* by long, narrow form, very highly polished shell and simple mantle margin of animal, spire long, body whorl subcylindrical, height of shell 10 to 18 mm., width 5 to 9 mm. **Aplexa hypnorum**

E. Spire elevated, dextral.

a. Adults under 20 mm. in height, columella without well-marked fold.

aa. Columellar lip not broadly reflected.

1. Rather slender, growth lines numerous with usually some coarser wrinkles, sometimes faceted by a few coarse spiral wrinkles intersecting growth lines, aperture narrow and half the length of shell or more, base rather produced, whorls 5, height 8 to 13 mm. **Lymnæa obrussa**
2. Short spired form of *obrussa* **Lymnæa obrussa modicella**
3. Smaller, spire shorter and less sharp, base less produced than in *obrussa*, whorls 5, height 7 to 9 mm. **Lymnæa humilis**
4. Growth lines fine and numerous, latticed (under lens) by fine, *raised* intersecting spiral lines, whorls 5 or 6, more convex than in *obrussa*, aperture shorter and more nearly circular, height 10 to 15 mm. **Lymnæa caperata**

bb. Columellar lip broadly reflected.

1. More slender than *humilis*, spire longer and more turreted, aperture more regularly elliptical. **Lymnæa parvus**
2. Smooth, shorter than *obrussa* in proportion to height, aperture somewhat longer than *caperata*, growth lines not crossed by spiral raised lines, whorls 5, height 9 mm., width 5 mm. **Lymnæa bulimoides**
3. Spire shorter, form more globose, umbilicus larger than *bulimoides*. **Lymnæa bulimoides cockerelli**
4. Spire acutely conic, whorls 5 or 6, finely striate, usually malleated, facets obliquely descending, umbilicus large, columellar lip very broadly reflected. **Lymnæa bulimoides techella**

b. Adults over 20 mm. in height, with distinct oblique fold across columella.

aa. Very large, whorls 6½, last large and inflated, spreading columellar callus closely appressed, completely covering umbilicus. **Lymnæa stagnalis appressa**

bb. Smaller, whorls 6, last not so large in proportion to spire, columellar callus not entirely covering umbilicus.

1. Growth lines crowded, crossed by numerous fine, incised spiral lines and sometimes several coarse, elevated wrinkles, whorls rather flat, peristome thin, white, with brown band edging callus within. **Lymnæa palustris**
2. Very long spire, whorls flat. **Lymnæa palustris elodes**
3. Body whorl and aperture wider, whorls rounded and somewhat shouldered. **Lymnæa sumassi**

Catalogue of Colorado Mollusca

[The references are to publications listed in the preceding bibliography, the figures in bold-faced type indicating the number of the publication in the bibliography, the light-faced figures indicating the page. The published records and synonomy appear first, followed by our new records and occasional comments.]

Genus ANODONTA (Bruguiere *Em.*) Lamarck

Anodonta grandis gigantea Lea. Pl. I, fig. 1.

Anodonta plana Lea, collected by Mr. Chas. T. Simpson in Lodge Pole Creek, Cockerell **22**, 61.

We find no other other record. *A. plana* has been since placed in synonomy of *A. g. gigantea*, but the validity of the subspecies may be doubted, in which case this record would stand as *A. grandis* Say.

Genus STROPHITUS Rafinesque

Strophitus edentulus pavonius Lea. Pl. I, fig. 2.

Stiangely enough, this large species does not appear to have been recorded from Colorado, although it likely occurs in all streams of the plains bordering the mountains at least from Denver northward. We have received specimens collected by Prof. A. E. Beardsley in the Cache la Poudre near Greeley, by Prof. D. W. Spangler in the St. Vrain at Longmont, by Prof. E. Bethel in a lake near Denver and have collected them in the Platte near Evans and in the Crow Creek water-holes, 25 miles northeast of Greeley. Some of Prof. Bethel's specimens reached a length of 140 mm.

Genus ANODONTOIDES Simpson

Anodontoides ferrussacianus Lea. Pl. I, fig. 3.

Anodonta jerussaciana, collected by Mr. Simpson in Lodge Pole Creek. Cockerell **22**, 61.

Genus LAMPSILIS Rafinesque

Lampsilis ventricosa Barnes. Pl. I, fig. 4.

Unio occidens Lea. Collected by Mr. Simpson in Lodge Pole Creek. Cockerell **22**, 61.

Lampsilis anodontoides Lea. Pl. II, fig. 5.

Unio anodontoides. Lodge Pole Creek, Simpson **48**, 430.

Lampsilis luteola Lam. Pl. II, fig. 6.

Unio luteolus, eastern Colorado, Simpson **47**, 88.

Unio tetralasmus camptodon Say. Pl. II, fig. 7.

Four or five specimens were collected by Prof. A. E. Beardsley, in Carrizo Creek, in 1881, but had never been recorded.

Genus SPHÆRIUM Scopoli

Sphærium occidentale Prime.

Pond near Black Lake, Cockerell **22**, 65.

Sphærium hendersoni Sterki. Pl. II, fig. 8.

Crow Creek water-holes, Sterki **61*a***. 69.

The type-specimens of this fine, large species were found by the University of Colorado Pawnee Butte expedition. They occur in large numbers in the Crow Creek water-holes northeast of Greeley, and have as yet been found nowhere else in Colorado. Dr. Sterki writes: "A species from the Mississippi Valley, etc., may possibly be of the same species, not described so far as I know."

Specimens collected by Prof. Beardsley in the Cache la Poudre, near Greeley, much resemble *S. striatinum* Lam., but the shells are heavier and there are other minor differences. Another lot obtained by the same collector at the head of Rio Grande Canyon, 12 miles from Antonita, Conejos County, do not seem referable to any known species. Further material, especially from other localities, and further study of these two forms are desirable before deciding whether they are new. A few dead shells collected by Prof. E. Bethel near Meeker are near *S. striatinum.*

Genus **CALYCULINA** Clessin

Calyculina partumeia Say.

Sphærium partumeia, Saguache and Rio Grande, Yarrow **68**, 949, 950.

Calyculina securis Prime. Fig. 1 (enlarged + ½).


Fig. 1

A few rather small specimens, not quite typical in surface appearance, were collected by Mr. D. M. Andrews in a small lake between Magnolia and Rollinsville, in the mountains west of Boulder. Further specimens from other localities are desirable, to determine whether the variation is constant.

Calyculina rykholti Norm.

Saguache, Sterki **60**, 93. Specimens referred to this European species with hesitation.

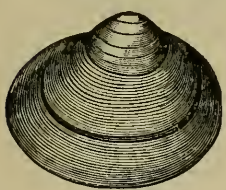
Fig. 2

Genus **PISIDIUM** Pfeiffer

Pisidium abditum Hald. Fig. 2 (very much enlarged).

Hot Springs, Animas Valley and St. Mary's Lake, Ingersoll **35**, 407. Empire, Ingersoll **37**, 134. Middle Lake of the Clouds, Powderhorn and East Fork Surface Creek, Cockerell MSS.

Pisidium noveboracense Prime.

We have obtained a few specimens from a ditch east of Boulder, but they are "small and not characteristic" (Sterki MSS.).

Pisidium variabile Prime.

Rio Grande of Colorado, Yarrow **68**, 951. Custer Co., Cockerell **22**, 64.

Pisidium compressum Prime.

Found by the University Pawnee Butte expedition in a small stream emptying into the Big Thompson near Loveland.

Pisidium friersoni Sterki.

Denver, Sterki **61**, 20.

Prof. Cockerell, to whom Dr. Sterki's specimens were credited, informs me that they were in fact collected by Prof. E. Bethel. We have collected the species from Owen's Lake and ditches east of Boulder and have received a few collected by Prof. E. A. Kenyon at Florence.

The *Pisidia* of Colorado are not sufficiently understood at present. The writer has collected several forms in the mountains west of Boulder, up to an altitude of over 10,000 feet, which have not yet been satisfactorily worked up. Dr. Sterki, who has examined our material, suggests the importance of thoroughly studying the genus with reference to differences shown by specimens from various elevations. For this purpose large collections from many localities are desirable, each lot from each locality to be carefully kept separate.

Dr. Sterki writes that "a forthcoming monograph of the North American *Pisidia* is expected to give as much in the way of comparison of species with each other as can be given in the present (or then) state of our knowledge," which will be an important contribution, as the original descriptions were evidently not written for comparative purposes.

[*Concluded in next number of these "Studies."*]

EXPLANATION OF PLATES

PLATE I

FIG. 1. *Anodonta grandis gigantea* Lea.

FIG. 2. *Strophitus edentulus pavonius* Lea. *a*, from Denver; *b*, from Greeley.

FIG. 3. *Anodontoides ferussacianus* Lea.

FIG. 4. *Lampsilis ventricosa* Barnes.

PLATE II

FIG. 5. *Lampsilis anodontoides* Lea.

FIG. 6. *Lampsilis luteola* Lam.

FIG. 7. *Unio tetralasmus camptodon* Say. From Las Animas County.

FIG. 8. *Sphærium hendersoni* Sterki. From Crow Creek, photographed from cotypes, the first published figure.

Fig 2*b*. $\times \frac{2}{3}$

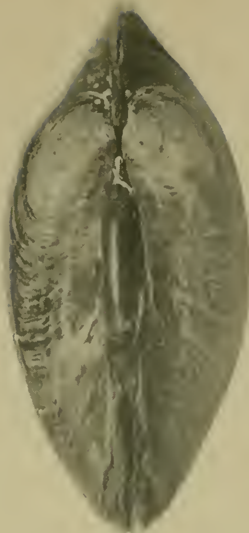

Fig. 4*b*. $\times \frac{2}{3}$

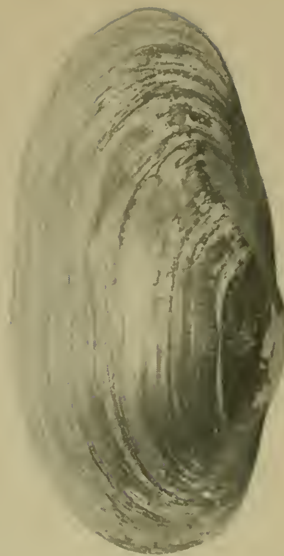

Fig. 2*a*. $\times \frac{2}{3}$

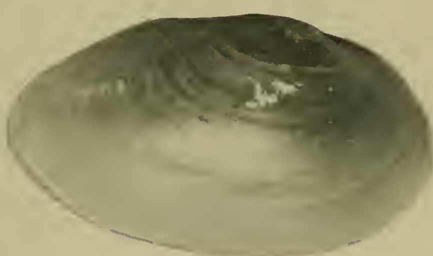

Fig. 1*a*. $\times \frac{2}{3}$

Fig. 3*a*. $\times \frac{2}{3}$

Fig. 1*b*. $\times \frac{2}{3}$

Fig. 4*a*. $\times \frac{2}{3}$

Fig. 3*b*. $\times \frac{2}{3}$

Mollusca of Colorado

Plate I

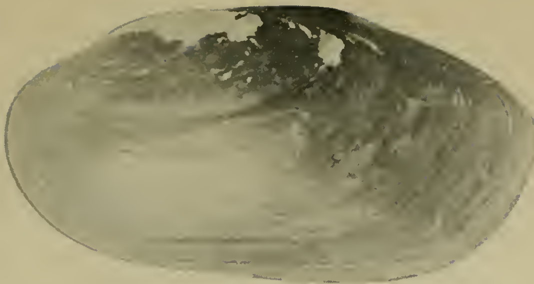

Fig. 5*a*. $\times \frac{2}{3}$

Fig. 5*b*. $\times \frac{2}{3}$

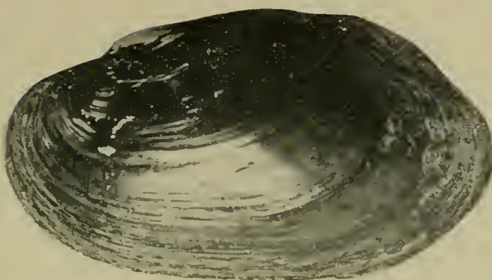

Fig. 6*a*. $\times \frac{2}{3}$

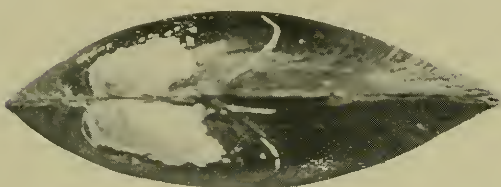

Fig. 6*b*. $\times \frac{2}{3}$

Fig. 8*b*. $\times 1 \frac{2}{3}$

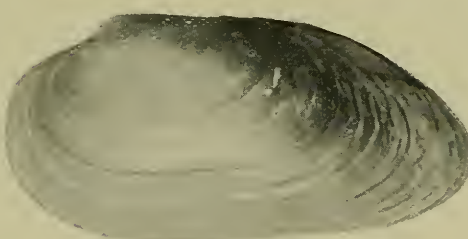

Fig. 7*a*. $\times \frac{2}{3}$

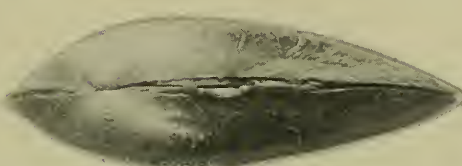

Fig. 7*b*. $\times \frac{2}{3}$

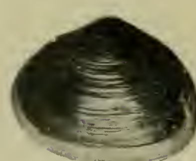

Fig. 8*a*. $\times 1 \frac{2}{3}$

Mollusca of Colorado

Plate II

ON THE BRAIN OF ONE OF THE SALAMANDERS (*Plethedon glutinosus*)

By Gideon S. Dodds

Introduction

In a former[1] paper the author published an account of the cranial nerves of *Plethedon glutinosus.* In the following pages is given a description of the brain of the same form.

Before entering into the more minute account of the structure of the brain, a few notes of a general nature may be of interest to those without a knowledge of the technicalities of brain structure. *Plethedon glutinosus* is a salamander occurring in the eastern United States. It is chiefly terrestrial in its habits. It measures from 5 to 7 inches in length, the specimens used in this study being about 5 inches long. Such a brain as that of *Plethedon glutinosus* is an excellent example of a brain showing the various parts in simple relations, being in some respects better than the much studied brain of the frog. The brain of *Amblystoma tigrinum,* our common "water dog" in Colorado would be equally satisfactory.

Fig. 17 gives a good idea of the general external appearance of the brain. At first glance, it appears to have nothing in common with such a brain as that of man, but the difference is not so great as might be imagined, for, in such a brain as this one, there are present in simple form, the same parts which make up the brain of the higher vertebrates. The real difference between this brain and that of man is in the relative development of the different parts.

In the brain of higher forms, the enormous relative growth of the cerebral hemispheres has obscured the real structural relations of the different parts. Fig. 17 shows that in this brain, the cerebral hemispheres are not "hemispheres" at all, but instead, two somewhat cylindrical bodies, no more conspicuous than the other parts of the brain.

[1] "The Cranial Nerves of one of the Salamanders (*Plethedon glutinosus*)," *The University of Colorado Studies*, III. 87, 1906.

Yet these structures are the parts which in man and other mammals comprise by far the greater part of the brain. The *mesencephalon*, which in this brain is quite as conspicuous as the cerebral hemispheres, is the part of the brain which, in all vertebrates below the mammals, forms the optic lobes. In the mammals it forms four inconspicuous bodies known as the *corpora quadrigemina*, hidden away beneath the other parts of the brain. The cerebellum of higher forms, containing the well-known *arbor vitae*, or "tree of life" is represented in this brain by a small band of fibers crossing from one side of the brain to the other. It appears in Fig. 17 just back of the *mesencephalon*. The medulla oblongata, also clearly shown in this figure, shows on the other hand no very marked external differences from that of higher forms. This structure is much more constant throughout the vertebrate series than are the other parts of the brain. It is also of interest to note that the ten pairs of cranial nerves as shown here, both in their distribution and place of origin, correspond quite closely to the first ten of the twelve pairs of cranial nerves found in the human brain.

A study of the drawings made from sections, will give a good idea of the size and arrangement of the ventricles of the brain which also occur here in simple relations. It will be noticed also, that the gray matter, represented by the shaded portions of the drawings, is arranged around the ventricles, and that there is no layer of gray matter placed at the surface to form a cortex as in higher forms.

Methods and Terminology

On account of the small size of *Plethedon*, it was necessary to use microscopic methods in the study of this brain. Entire decalcified heads were embedded in celloidin and sections cut and mounted in series. Various stains were used. Borax-carmine and Delafield's haematoxylin each showed some features clearly. Weigert's haematoxylin (Pal's method) gave the best results for the peripheral distribution of nerves, and iron-alum haematoxylin for internal fiber tracts.

In this paper, so far as applicable, the Basel Anatomical Nomenclature [BNA] has been used. In some places, where the homology of the structure seemed doubtful, it seemed better to use some other terms rather than to use [BNA] terms of doubtful application. The terms of the [BNA] nomenclature as used here are from the table given by Hardesty ('02) in his "*Neurological Technique.*"

External Features

In external features, the brain of *Plethedon glutinosus* presents no striking differences from that of other Urodela. It resembles most closely that of *Desmognathus fusca* as described by Fish ('95). It measures 7 to 9 mm. in length and 2 to 2.5 mm. in width at the widest part. There is somewhat of a cervical flexure which is corrected by a more decided pons flexure, so that the general contour of the brain is straight. The brain by no means fills the cranial cavity, the relation being shown in Fig. 7.

The widest part of the brain is near the caudal extremity of the cerebral hemispheres, from which place it narrows toward the anterior end of the olfactory lobes. The diencephalon lies between the diverging caudal ends of the cerebral hemispheres. The mesencephalon is of the usual type in Urodela. The metencephalon (cerebellum) appears as a band running around the caudal end of the mesencephalon. The medulla is of the regular type found in Amphibia.

In this study no special attention was given to the meninges and blood supply. So far as observed they agree with the accounts of these features in other Amphibia.

General Morphology

Telencephalon—In this division of the brain are included the cerebral hemispheres and their forward extensions, the olfactory lobes. The cerebral hemispheres are somewhat cylindrical, and smaller in front than near the posterior end. Their caudal ends taper abruptly. Externally the posterior limit of the olfactory lobes is not clearly marked. It was not clear from my observations of the internal structure just where the limit should be placed. The olfactory glomerules lie near the surface of the antero-lateral aspect, somewhat toward the ventral surface. The large olfactory nerves, here as in other Urodela, arise from the antero-lateral angle of the rhinencephalon. The lateral ventricles extend well forward into the olfactory lobes, and their forward extremities curve inward so as nearly to reach the mesial surface.

In the hemispheres, the lateral ventricles extend the length of the segment. They communicate with the anterior part of the third ventricle by the slit-like interventricular foramen (foramen of Monro) (Figs. 11–16). The lateral ventricles are surrounded entirely by gray matter, and a conspicuous spur, known as Ammon's horn, extends forward from the posterior end of each hemisphere. The pallium is well developed, comprising quite a thickness of gray matter. The striated bodies appear as thickenings on the ventro-median walls of the hemispheres. On the dorsal median line, in the angle between the caudal ends of the hemispheres, appears the choroid plexus of the third ventricle, often called the supraplexus. It drops down into the brain and forms the anterior wall of the third ventricle above and forward of the lamina terminalis. It sends branches forward and backward. The forward extension reaches far into the lateral ventricles.

The lamina terminalis in Amphibia is generally considered as extending from the optic chiasma forward and upward to the choroid plexus. Immediately back of the interventricular foramen, there arises from the lamina terminalis an elevation which comprises the fibers of two commissural bundles (Figs. 10 and 16). The ventral bundle is the anterior commissure, the dorsal one the so-called corpus callosum. In *Plethedon* these bundles are separated at the median line by a single layer of cells, apparently continuous with the gray matter of either side. Almost immediately on either side, the dorsal bundle bends abruptly upward and the ventral one more slowly downward, so that they soon become separated by a considerable amount of gray matter (Fig. 5). The fibers of the upper tract take a course upward and forward to form the posterior and dorsal walls of the interventricular foramen and almost immediately spread out on the median and dorsal walls of the lateral ventricles (Fig. 16).

The question of the true homology of the dorsal bundle is a much debated one. It occurs in other Urodela in much the same relations as in *Plethedon*, and in Anura the conditions are essentially the same. It has quite generally been considered to be the homologue of the callosum.

The principal paper presenting this view is by Osborne.[1] He considers that there is no doubt that this is a true callosum, and bases his judgment upon a study of *Necturus* and *Proteus*. In these forms he found the dorsal bundle completely separated from the ventral and a fold of the plexus passing between them. Herrick,[2] moreover, recognized the cells here, a clearly defined, continuous film of epithelium separating them. He considers these two points of great value in determining the true relations of the bundle. The chief objection to its being called a callosum had hitherto been, that while the callosum forms the roof of the ventricle, this bundle forms the floor. The conditions observed by Osborne and Herrick are considered to mark the bundle as morphologically belonging to the roof of the ventricle and not to the lamina terminalis.

Other observers consider the conditions observed in these cases not normal. Kingsbury ('95) finds in larval forms of *Necturus*, that the two bundles are separated by several layers of cells, none of which are epithelial, and in twelve adult brains, he finds no separation by cells at the median line. This agrees with the observations of Fish ('95) and Mrs. Gage ('93) on *Necturus* and other forms. Fish does not agree that the tract is dorsal. Nevertheless he considers that it is a true callosum, and that a phylogenetic study clearly shows its homology. He holds that though the tract is of ventral origin, a continuous growth of the hemispheres would cause it to migrate upward and forward in the lamina terminalis until it would come to occupy a position that would approximate that of the callosum in higher vertebrates. To show the actual migration of the bundle, he presents a series of drawings from median sagittal sections from *Desmognathus*, *Cryptobranchus* frog, turtle, and bird. If we consider only the relations at the median line, he seems to make his point. But, as Kingsbury ('95) points out, he ignores the question of the distribution of the fibers as regards the interventricular foramen. The mammalian callosum is in *front* of the foramen and *above* the ventricle. The so-called callosum of Amphibia is *behind* the foramen and *below* the ventricle. "It is evident that however far cephalad and dorsad the terma [lamina terminalis] might be

[1] KINGSBURY, '95, p. 154. [2] *Ibid.*, p. 153.

bent, the relations of Amphibia could only be directly changed into those of higher forms by the migration of the bundle in question across the portas" [interventricular foramens]. (Kingsbury '95, 158.) This peculiar relation, he shows, has either been ignored by other writers or considered of no consequence. He, however, considers the objection a vital one and that the structure under question cannot be homologized with the mammalian callosum, though it may prove to be, in part at least, a hippocampal commissure.

It appears to the writer that we cannot look to a phylogenetic study of adult structures to settle the point in question. The importance of an embryological study seems to be overlooked. It seems highly probable that light would be shed upon this question by a comparative study of the embryology of the structures under discussion. Observations have been made upon larval forms, but no careful study upon early embryos. Work by cytological methods, comparable to that done upon mammalian and chick embryos might prove of great value. As no such work seems to have been done, a brief discussion and a few suggestions, based chiefly upon conditions observed in mammals and birds may be in place here.

The account of the origin of the mammalian corpus callosum as given by Minot ('92, 682) is of interest. Early in embryonic life, "the upper part of the lamina terminalis becomes much thickened to form a broad band of triangular section uniting the two hemispheres. This band is the anlage of the septum lucidum, the corpus callosum, the fornix, and the anterior commissure." At this time there are no fibers connecting the two hemispheres, and in fact, the hemispheres themselves are but slightly developed. The anlage of each of these commissures can be distinguished as a distinct area in this structure. Later, the fibers of these commissures grow across the median line from each side toward the opposite side through their respective areas. Thus we see that the corpus callosum, in its origin, belongs to the lamina terminalis and is not a dorsal structure as held by some writers. The callosum in birds and mammals arises in the lamina terminalis in a position homologous to that occupied by the "callosum" in adult Amphibia. Mrs. Gage's figures 66 and 67, from median sections of embryo *Diemyctylus* indicate that the origin of these commissures in this form is essentially the same as in higher vertebrates. In an embryological study, the course of the fibers with reference to the interventricular foramen must be considered. A comparative study of embryos may show that the transition from one condition to the other does not involve the supposed difficulties. To bring about such a change of relations we do not need to consider the fibers of the bundle as migrating across the foramen. The place of appearance of the anlage of these commissures varies somewhat in different forms. In birds and mammals it is *in front* of the foramen, while from Mrs. Gage's figures, already referred to, it appears that in Amphibia it is *below* the foramen. Now, it seems reasonable to suppose that in one case the fibers arising in a given part of the anlage, grow across above the ventricle and in front of the foramen and in the other case below the ventricle and behind the foramen. Thus the change of conditions might easily come about without the migration of the bundle as such across the foramen. To determine whether this is actually the case and clearly to identify the anlage of the "callosum" of Amphibia with its homologue in higher forms are questions for comparative embryology.

Diencephalon.—There is no marked line of separation between this segment and the mesencephalon. On the dorsal surface of this segment, at its forward extremity, appears the choroid plexus, which dips down and shuts off the cavity of the mesencephalon from the longitudinal fissure. In its folds lies the paraphysis. Just back of this are the habenulae and supracommissure, and just back of this the pineal body. The conspicuous features on the ventral surface are the large infundibulum and the hypophysis. The optic chiasma, at the forward limit of the diencephalon, lies sunken in the surface and makes no prominence. In this segment the cavity of the brain has its greatest dorso-ventral expansion but is of narrow lateral dimensions. Just in front of the chiasma, on either side, it expands into a narrow pocket, known as the preoptic recess, representing the primitive lumen of the optic vesicle. The ventricle sends off a ventral spur which enters the infundibulum by a narrow passage and then expands laterally to a considerable width. The dorsal and posterior wall of the infundibulum is composed of the pia and a single layer of epithelium. The hypophysis is closely applied to this. It is of two parts, a dorsal and a ventral, separated by a constriction (Figs. 10 and 16). The anterior part of the dorsal division is of a different nature from the rest of the body. Its exact structure was not clear in my sections. The rest of the organ is of a glandular structure. In the diencephalon, the choroid plexus divides into two main branches; a ventral one extending toward the cavity of the infundibulum, and a dorsal one extending backward into the cavity of the mesencephalon as far as the cerebellum.

In the roof of the diencephalon, just back of the choroid plexus, are the habenulae, and closely associated with them the supracommissure. Immediately back of the habenulae, the dorsal wall of the brain becomes thinned, till it consists of only a single layer of epithelium. Lying just above this is the pineal body. It is a very much flattened sac of one or two layers of cells. There is a distinct cavity, but it has no connection with the cavity of the brain, though the thinning of the wall of the brain at this place no doubt represents the pineal recess, the primitive lumen of the organ. In the lateral walls of the diencephalon are indefinite gatherings of gray substance, but no distinct optic thalami.

Mesencephalon.—The anterior boundary of this segment on the dorsal surface is generally considered to be just in front of the posterior commissure, and on the ventral surface, just forward of the origin of the third nerve. As has been found to be the case in other Urodela in distinction to the condition in Anura, there is no dorsal separation of this segment into a pair of gemina. The roof is nearly circular in outline and somewhat flattened. The cavity of the brain in this segment expands laterally to a considerable width, but decreases greatly in height. Backward it narrows again and leaves the segment as a narrow passage. The gray matter of the roof shows separation into two layers, as is common in Urodela. The posterior commissure crosses, deeply intrenched in the gray matter of the roof and sides of this part of the brain. The external layer of white matter of the dorsal and lateral portions of the mesencephalon contains the optic fibers. These course forward and downward over the sides of the diencephalon to form the optic tract (Figs. 11–15).

Metencephalon.—The cerebellum is an inconspicuous part of the brain. It curves around the posterior surface of the mesencephalon, and is composed chiefly of white matter. It comprises the fibers of two commissures. A single layer of cells surrounds the white matter. Its appearance on the dorsal surface of the brain is shown in Fig. 17, and its appearance on transection in Figs. 10 and 16.

Myelencephalon.—This part of the brain is of the usual Amphibian type. The fourth ventricle is covered by a choroid plexus. The cranial nerves from the fifth to the tenth arise from this segment. The gradual transformation from medulla to spinal cord takes place in the usual way.

Fiber Tracts

In the Amphibian brain, several well-defined fiber tracts are clearly recognizable. Some of these can be pretty satisfactorily homologized with structures in higher vertebrates while the homologies of others are doubtful. Regarding the names applied to some of these there is also no very great agreement. The terms used in the following description, are, so far as could be determined, those most generally used.

Posterior longitudinal fasciculus.—The fibers of this tract can be distinguished as a well-marked bundle in the ventral part of the medulla (Fig. 8). Thence they pass forward into the mesencephalon, where they cannot longer be distinguished as forming a definite tract.

Basal prosencephalic tract.—The fibers designated by this name form a tract which has been described under various names. Kingsbury ('95) uses the term adopted here. This was used before by Edinger. In sagittal sections it appears to be a forward continuation of the posterior longitudinal fasciculus, though the fibers are probably not continuous. In cross-section it appears as a very definite bundle on either side of the median line (Figs. 5 and 6). Beginning well back in the mesencephalon, it can be traced forward into the ventral part of the hemispheres. The fibers of this bundle are mostly non-medullated.

Anterior commissure.—This commissure is composed chiefly of non-medullated fibers, and by the methods used, it could not be traced very satisfactorily. The main bundle on either side of the median line inclines slightly downward and then passes forward just below the basal prosencephalic tract. The two bundles soon become indistinguishable as separate tracts. Probably a part of this tract turns backward, but this could not be very definitely determined. This part is commonly present in Amphibia. Medullated fibers enter the commissure from the basal prosencephalic tract from before and from behind. They may possibly be decussating fibers.

"*Corpus callosum.*"—The tract designated by this name has been fully described elsewhere. The term corpus callosum is probably not a proper one for this structure, as it more likely represents a hippocampal commissure. However, it is simpler, and less likely to lead to confusion, to use the old term till we have sufficient knowledge of the structure to apply a fitting new one. In *Plethedon* the fibers of this tract are chiefly non-medullated.

Supracommissure.—In the region of the habenulae, in sagittal sections, three separate bundles can be distinguished crossing the median line (Fig. 10). The most anterior of the three occupies a position at the very forward part of the habenulae. It is by far the smallest of the bundles. It could not be traced for any considerable distance. It is probably composed of commissural fibers between the habenulae of the two sides. It may possibly represent the commissura habenularis (Edinger, '99, p. 126 *et seq.*). In accounts of other Urodelan brains, so far as I have been able to learn, only two bundles are described at the median line. The other two bundles correspond to the supracommissure as described for other Urodela. These two bundles on either side of the median line, soon unite, at least apparently, into one bundle. Probably, however, the two parts really remain distinct. The bundle passes in a ventral direction on either side, and soon, from its posterior part fibers begin to be given off backward; finally a quite distinct bundle passes backward into the diencephalon. The remainder of the bundle, probably representing the middle part at the median line passes forward and outward into the hemispheres.

Meynert's bundle.—The bundle generally described under this name in Amphibia is the tractus habenulo-peduncularis described by Edinger. ('99, pp. 131, 132 and 306). In *Plethedon*, as in other Urodela, it is a compact bundle of non-medullated fibers. It arises from the habenulae, just back of the supracommissure. Its fibers at first take a course backward and a little downward as a loose bundle. Then turning more directly ventralward they form a small but compact bundle. Near the ventral surface of the brain, the bundle again turns backward and ends in the gray matter on either side of the median line, just in front of the origin of the third nerve (Figs. 12–15).

Posterior commissure.—The fibers of this commissure cross deeply intrenched in the gray matter of the mesencephalon some little distance back of Meynert's bundle (Figs. 11–14). They take a course downward and backward as a quite definite tract of medullated fibers, but the tract soon becomes less compact, so that its relations could not be determined.

Cerebellum.—As before stated, two bundles of fibers can be distinguished, a ventral one and a dorsal one. The ventral bundle is the smaller of the two and its fibers curve forward into the mesencephalon. The fibers of the dorsal bundle pass backward into the medulla. A fold of the pia separates this bundle from the mesencephalon.

Mauthner's fibers.—These are not very distinct, but fibers probably representing them, can be distinguished in the ventral part of the cord and medulla. They were not traced to their termination in the medulla. In my sections one of these fibers is much larger than the other one.

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Description of Figures

FIGS. 1–9 are from cross-sections of the brain in order from before backward. They are not cut directly across the brain, so that the two sides are somewhat different. Magnification × 25.

FIGS. 1, 2.—Through the olfactory lobes.

FIGS. 3, 4.—Through the cerebral hemispheres.

FIG. 5.—Through the cerebral hemispheres and the diencephalon.

FIG. 6.—Through the diencephalon.

FIG. 7.—Through the mesencephalon, showing the brain in place in the cranium.

FIG. 8.—Through the medulla at origin of the auditory nerve.

FIG. 9.—Through the spinal cord just back of the medulla.

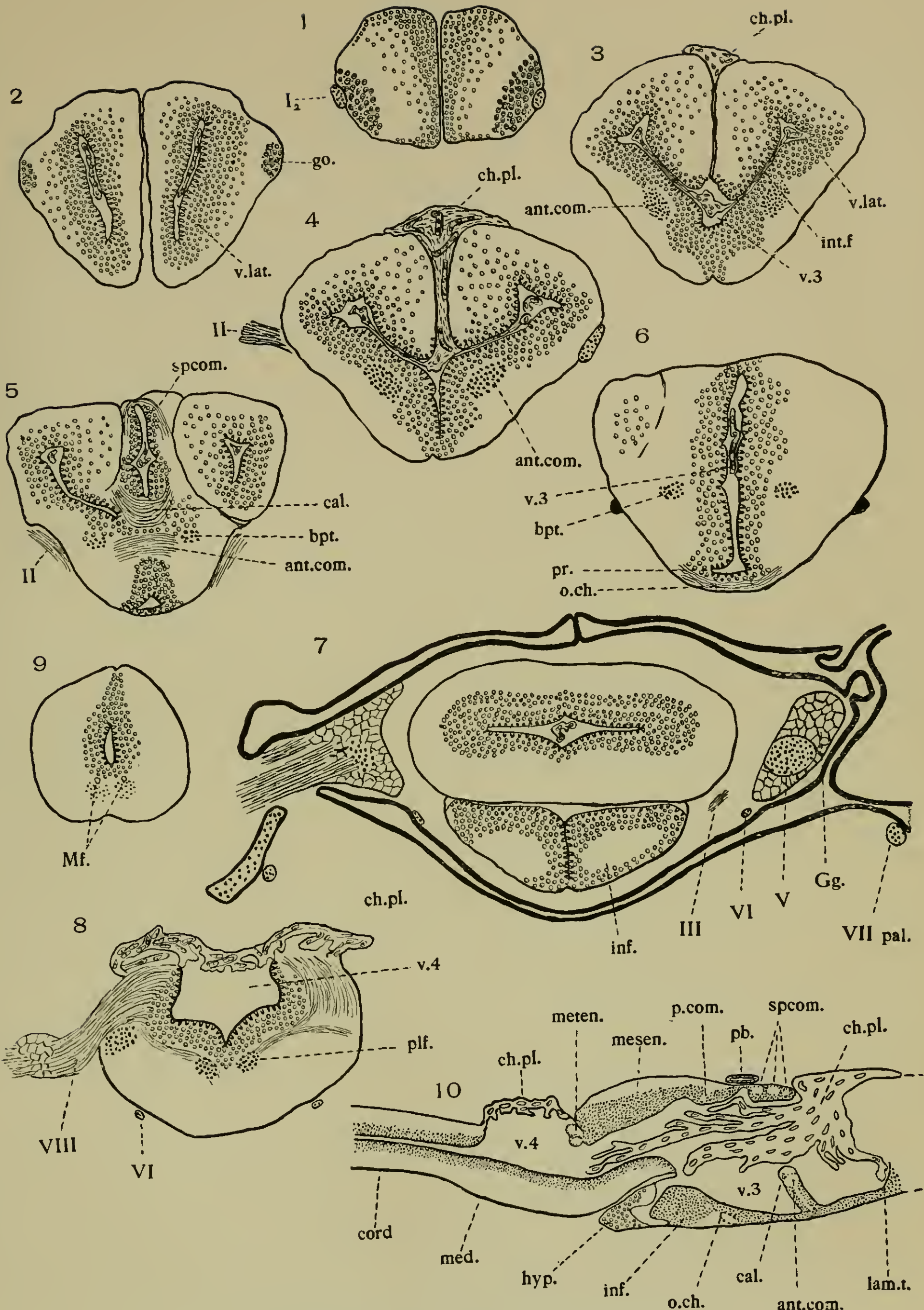
FIGS. 10 and 16 are from sagittal sections. Magnification × 12. Fig. 10 shows the parts of the brain as they would appear in a median sagittal section. This drawing was made by comparison of a number of sections from different brains. Fig. 16 is from a nearly sagittal section a little to one side of the median line. This shows especially the relation of the fibers of the corpus callosum to the interventricular foramen.

FIGS. 11–15 are from frontal sections in order, from the dorsal toward the ventral side of the brain. Magnification × 12. The sections are cut a little lower on one side than the other. They give a good idea of the size and arrangement of the ventricles of the brain.

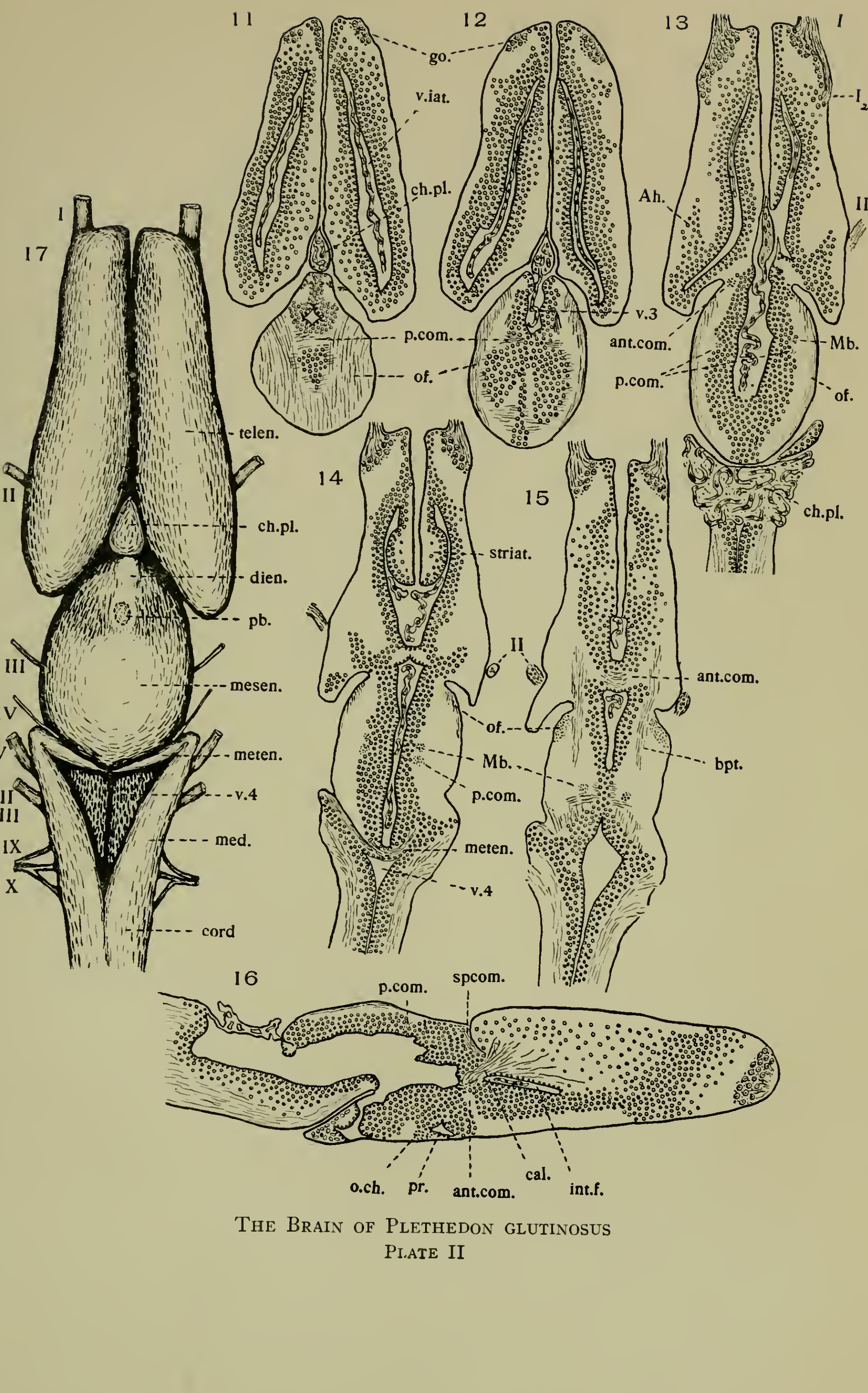
FIG. 17 is a dorsal view of the entire brain, ×12.

Reference Letters

I–X, the cranial nerves.
Ah., Ammon's horn.
ant. com., anterior commissure.
bpt., basal prosencephalic tract.
cal., corpus callosum.
ch. pl., choroid plexus.
cord, spinal cord.
dien., diencephalon.
Gg., Gasserian ganglion.
go., olfactory glomerules.
hyp., hypophysis.
int. f., interventricular foramen.
inf., infundibulum.
lam. t., lamina terminalis.
Mb., Meynert's bundle.
med., medulla oblongata.
mesen., mesencephalon.
meten., metencephalon.
Mf., Mauthner's fibers.
o. ch., optic chiasma.
of., optic fibers.
pb., pineal body.
p. com., posterior commissure.
plf., posterior longitudinal fasciculus.
pr., preoptic recess.
rhinen., rhinencephalon.
spcom., supracommissure.
striat., corpora striata.
telen., telencephalon.
v. lat., lateral ventricle.
v. 3, third ventricle.
v. 4, fourth ventricle.



THE BRAIN OF PLETHEDON GLUTINOSUS
PLATE I



The Brain of Plethedon glutinosus
Plate II

THE SILVA OF COLORADO[1]

I. Trees of the Pine Family in Colorado

By Francis Ramaley

Our principal forest trees.—The trees of the pine family are of such value to Colorado that some account of them should be useful. The early settlers used native wood for fuel before coal was mined; and native pine and spruce furnished the material for building purposes and for mine timbers. Even at the present time a considerable amount of timber is being cut in all our mountian counties. Aside from the pines, spruces and firs there are few trees of economic value in the state. Along the rivers and creeks the various cottonwoods and willows occur. On the mesas and foothills west of the front range there are in many places large groves of quaking aspen, but all of these trees are used chiefly for firewood and not for lumber as are the pines and spruces.

The value of forests is not merely in the lumber which may be cut from them. In all mountain regions forests are needed for protection. A protection forest saves the soil from being washed away,[2] it prevents too rapid melting of snow and consequent floods and it provides steady stream-flow for irrigation in the lowlands. Without forests on our hills and mountains there could be little agriculture in Colorado. Wherever mountain forests are dense the soil is deep and, retaining moisture for a long time, furnishes the streams with a constant supply of water doled out little by little through the season.

Some economic considerations.—Large areas in the foothills and in the mountains of Colorado can never be used for agriculture or for mining. If they are to be made productive they must be allowed to grow up with trees. Fires must be kept down and the forests protected from injury of all kinds. Many of the partly denuded hillsides can be clothed with timber in thirty or forty years. The time is coming soon

[1] This paper is one of a series which will deal with the trees and shrubs of Colorado.

[2] As is well known, France and other European countries have suffered severely from deforestation of mountain slopes. Not only have the hillsides been denuded of soil but much of the lowland country has been ruined by the sand and gravel washed down upon it.

when the value of timber will be much greater than it is now. It will pay individuals and corporations to grow trees for the market. Despite the opening up of new coal mines and the employment of brick, stone and metal for building purposes the use of lumber is on the increase. Thus between 1880 and 1900 the population of the United States increased 52 per cent., but during the same time the annual cut of lumber increased 94 per cent. While the annual cut in the last few years is probably not much greater than in 1900, the value has increased considerably and it is to be expected that the rise in price of all wood products will continue indefinitely. A few years ago the northern white pine furnished one-half of all the lumber used in the United States. Now only about 15 per cent. of the annual cut is from this species. The southern hard pines and the Douglas spruce, or "red fir," as well as the redwood of the Pacific coast are being more and more extensively used.

Our native trees may be a source of wealth.—In Colorado the Douglas spruce is native, growing in canyon bottoms and on moist hillsides. With proper protection of the young trees and the carrying-out of a scientific forest policy this species may furnish in future much valuable timber. The rock pine, or "western yellow pine," and the Engelmann spruce will become important. Even the lodgepole pine can be made useful for many purposes when proper methods of seasoning are employed and if suitable treatment is used to prevent decay. The pinyon pine makes excellent charcoal and is a good fuel.

Forests as places for recreation.—Aside from the value of our coniferous forests for protection of watersheds and as a source of timber for mines and for building purposes, they form a valuable asset in attracting tourists to the state. The forests of the mountains form important recreation grounds which are being used by our own citizens and by summer visitors. Each year the number of tourists is greater than the year before and each year more money is brought into the state just because of our mountains and our forests. Indeed, without trees our mountains would offer slight attraction to visitors. I take the liberty of quoting the following from an address by the well-known student of nature, Mr. Enos A. Mills, of Estes Park, Colo.:

People are feeling the call of the wild. They want the wild, wild world beautiful. They want the temples of the gods, bits of the forest primeval, the pure and fern-fringed brooks. They like to stand "knee-deep in June," they demand the shadow of the pines, and have them they will. Above Colorado's purple forests there are alpine meadows bannered with rare blossoms, and crags and snow go up into the blue. Timber line tells stirring stories of the forest frontier. The sunny grass plots in the forest are delightful wild gardens with flowers, crags, and brooks that shine in silver. There are still bits of dark forest in which one may hear the music of the pines and the songs of white cascades.

Forest reserves in Colorado.—What the officers of the United States forest service think of the necessity for forests in Colorado may be learned form the extent of the reserves established in the state.[1] On December 31, 1905 there were fourteen such reserves with a combined area of nearly thirteen million acres, or about one-fifth the total area of the state. California is the only state with a larger area of forest reserves. Lumber to the amount of seventeen million feet was sold from the Colorado reserves during 1905. In addition there were ten thousand cords of fuel wood and fourteen thousand posts and poles. In the future, with suitable protection against fire and scientific regulation of lumbering operations the reserves may be expected to furnish a much larger output.

"The Silva of Colorado."—Under this heading it is proposed to publish from time to time articles dealing with the trees and shrubs of the state. Some of the articles will have to do with botanical questions relating to particular trees; some will discuss forest areas; some will be strictly technical; some will be intended for popular use. In the following pages are given descriptions of trees of the pine family. By means of keys and also through the introduction of figures it is hoped to make plain the differences between the species, and to make it possible for persons without botanical training to distinguish these trees when growing in the forest.[2] For most purposes a comparison of the tree with the account in the following keys will be sufficient; rather full descriptions are, however, given for the use of students.

Books dealing with the trees of Colorado.—The greatest work on

[1] *Yearbook of Dept. of Agriculture for 1905*, pp. 636–644.

[2] For certain points in the following descriptions the writer is indebted to D. M. Andrews, Esq., of Boulder, Colo.

North American trees is the *Silva of North America* by Chares Sprague Sargent, in thirteen folio volumes. The cost of this work, however, makes it impossible for any but the wealthiest individuals and institutions to own it. A short work in one volume by the same author is very serviceable. It is the *Manual of the Trees of North America.*[1] This book contains illustrations of leaves and fruit of every tree known to grow in North America north of Mexico. General works on botany also contain descriptions of trees. Coulter's *Manual of the Botany of the Rocky Mountain Region,*[2] issued many years ago, is the book most accessible since it is found in every high-school library. Unfortunately the tree descriptions there given do not correspond exactly with the species as recognized today. A useful little book is Professor Aven Nelson's *Key to the Rocky Mountain Flora,*[3] in which short but accurate descriptions of most of our trees are given. Very useful to the trained botanist is Rydberg's *Flora of Colorado,*[4] recently issued. Another important work is a "Report on the Forest Conditions of the Rocky Mountians" by various authors issued as *Bulletin No. 2 of the Forestry Division of the United States Department of Agriculture.* The second edition of this bulletin was issued in 1889. Professor Sargent's "Report on the Forests of North America" prepared for the Tenth Census[5] contains much information in regard to the commercial value of different trees. Many of the native trees of the Rocky mountain region were first described in the accounts of the early expeditions conducted by the United States government but this material is now gathered in later publications so that reference to these works is not necessary.

The Pine Family.—As here limited the pine family in Colorado (Pinaceae) includes the pines, spruces and firs. All bear true cones which become hard and dry, never berry-like as in the junipers and cedars. In addition to the seed-bearing cones there are the pollen-bearing cones which produce the pollen spores in the spring. These are smaller cones; when the pollen has been shed they soon wither

[1] Boston: Houghton, Mifflin & Co., 1905, pp. 826.

[2] New York: American Book Co., pp. 452.

[3] New York: D. Appleton & Co., 1902, pp. 94.

[4] *Bull. 100, Agr. Exp. Sta. Colo. Agr. College,* Fort Collins, Colo., 1906, pp. 447.

[5] *Tenth Census of the United States,* Vol. IX, pp. 612.

Pinus flexilis × ⅔ Pinus edulis × ⅔ Pinus scopulorum × ⅔

Pseudotsuga mucronata × ⅔ Picea engelmanni × ⅔ Abies lasiocarpa × ⅔

THE SILVA OF COLORADO

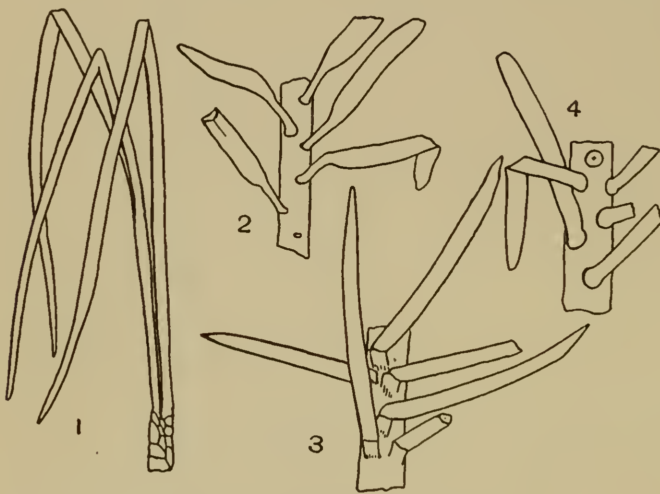
and dry up so that they are not seen except in spring and early summer. Members of the pine family are easily recognized by the needle-like leaves. The Colorado species, and in fact nearly all cone-bearers are evergreen. This condition is, however, not an essential in the family, for the larches, or tamaracks, of the northern states are deciduous. Throughout the northern hemisphere the pines and their allies are the most important of all woods for building purposes. The wood of the true pines is the most generally used. Two distinct kinds of pines are recognized, viz.: the hard pines or "yellow pines" and the soft pines, "white pines." Douglas spruce ("red fir" "Oregon pine") has wood resembling the hard pines in quality. Firs and true spruces have inferior wood. In fact, the wood of trees in the highest mountains is generally not strong but light and brittle. This fact is easily understood when it is known that the hard part of wood is that formed in the summer. Tropical woods are often hard and heavy. Trees of mountain tops—the spruces and firs—do not exist in conditions of summer and hence do not develop hard and strong wood. Spruce is, however, valuable as a source of wood pulp for making paper. The wood of all the trees of the pine family is known as "non-porous" because there are no vessels, or "pores" in it. Like the hardwoods it is most durable when "quarter-sawed."

Species of the pine family in Colorado.—Ten species are known in Colorado. Of these there are five[1] pines, two true spruces, one Douglas spruce and two firs. The four genera are easily distinguished and it is not difficult to recognize most of the species. However, very few residents of the state and still fewer visitors know them apart. In fact it is quite common to hear them all called pines. It is hoped that the following keys and descriptions will be useful to those interested. There is no good reason why miners, engineers and citizens generally should not know our forest trees.

How to use the key and descriptions.—First be sure that the specimen to be examined is one of the pine family (with needle leaves). These keys and descriptions do not include any account of the junipers

[1] Rydberg in the *Flora of Colorado* credits the state with one more species of true pine, but I have omitted a description of it since its occurrence is somewhat doubtful.

and cedars; they have flat scale-shaped leaves. Now with specimens of the twigs and cones at hand turn to the "Key to the Colorado genera of the Pine Family" on p. 115. Read what is given after **A** and after **B.** If the specimen agrees with the description **A** it belongs to the genus *Pinus*, the pines, and the particular species may be learned by a study of the key to that genus on p. 116. If the specimen is not a pine it will be described by the paragraph **B.** In that case read **a** and **b.** If the description **a** is satisfactory the specimen is a true spruce of the



Leaves of the Different Genera
1. *Pinus;* 2. *Pseudotsuga;* 3. *Picea;* 4. *Abies.*

genus *Picea* and the species may be determined by a study of the key to that genus. In like manner, if the specimen belong to either of the other genera, that fact will be apparent on reading down the key; reference may then be made to the appropriate key for fuller information and for determination of the particular species. Sometimes it is impossible to secure cones but even then the genus may be determined and the tree identified as a pine, spruce, Douglas spruce or fir. In fact the species itself may usually be told without the cones, especially when the tree is a typical one of its species.

Family **PINACEAE**,[1] PINE FAMILY

Trees and shrubs with needle-like foliage leaves; usually resinous. Flowers appearing in spring, strobillate. Staminate strobili relatively small, consisting of numerous microsporophylls borne on an elongated axis, the pollen sacs producing a large quantity of pollen. Carpellate strobili consisting of spirally arranged cone scales each accompanied (in most cases) by a bract which is shorter or longer than the scale. Cone scales becoming woody or papery at maturity. Seeds with straight embryo embedded in copious endosperm.

KEY TO THE COLORADO GENERA OF THE PINE FAMILY[2]

A. Foliage leaves (needles) in bundles of two or more surrounded at base by a short sheath. Leaves mostly more than 25 mm. (1 in.) long. Cones hard and woody when mature. 1. Genus **Pinus**
(See the Key on p. 116)

B. Foliage leaves (needles) solitary, not in bundles; mostly less than 25 mm. (1 in.) in length. Mature cones leathery or papery; not hard and woody.

- a. Leaves jointed near the base, the lower part of the leaf brown and woody and remaining on the branchlet after the rest of the leaf has fallen. Leaves in our species stiff and four angled, not flat. Cones pendulous. 2. Genus **Picea**
(See the Key on p. 119)
- b. Leaves not brown nor woody at base, flat. When they fall off they they leave a scar but no part of the leaf remains.
  - a′ Leaves rather soft; narrowed toward the base into a short stalk which broadens slightly at the point of attachment. Leaf-scars transversely elliptical. Cones pendulous, the projecting bracts three-pointed. 3. Genus **Pseudotsuga**
(See the Key on p. 120)
  - b′ Leaves somewhat stiff, not narrowed at base; leaf scars rather large, circular in outline. Cones erect, dark purple or blackish or sometimes yellow. 4. Genus **Abies**
(See the Key on p. 122)

Genus **PINUS**, THE PINES

Evergreen trees and shrubs, growing often in dry and rocky soil; wood of most species valuable for timber. Bark thick and furrowed. Foliage leaves needle-shaped, in bundles usually of 2 to 5 leaves or in some species 6 or 7; rarely single. The foliage leaves are borne on very short twigs (dwarf shoots), which arise in the axils of appressed scale leaves and are surrounded at the base by a short sheath. Flowers monosporangiate; the staminate clustered at the base of leafy shoots of the same year. Stamens (microsporophylls) very many, spirally arranged. Car-

[1] In addition to the works previously cited the author has consulted for the technical descriptions *A Handbook of the Trees of California* by Miss ALICE EASTWOOD and "The Conifers of Vancouver Island," by F. K. BUTTERS in *Postelsia*, the yearbook of the Minnesota Seaside Station, pp. 135–212, 1906. For the use of a copy of the former book he is indebted to Miss Eastwood and to Miss Alice Phelps, a student of the University of Colorado.

[2] The cedars and junipers are not included here. A later paper will be devoted to them.

pellate flowers solitary or clustered. Cone scales thick, becoming woody; bracts short in comparison with the scales. The cones ripen the second year or later. The genus Pinus is widely distributed throughout the northern hemisphere and extends to the Philippine Islands and Sumatra. In the United States and British North America there are about 36 species.

Key to the Colorado Species of the Genus Pinus

A. Leaves in bundles of 4 to 6; medium sized or small trees, chiefly in high altitudes.
  - a. Leaves 25 to 40 mm. (1 to $1\frac{5}{8}$ in.) long. Cones 7 to 9 cm. ($2\frac{3}{4}$ to $3\frac{1}{2}$ in.) long, the scales with curved, needle-pointed spines. 1. **Pinus aristata**
  - b. Leaves 3.5 to 7.5 cm. ($1\frac{3}{8}$ to 3 in.) long. Tree of wind-swept mountain sides or exposed points. Cones large, 7 to 25 cm. ($2\frac{3}{4}$ to $9\frac{3}{4}$ in.) long, the scales smooth, without spines. 2. **Pinus flexilis**

B. Leaves in bundles of 2 or 3.
  - a. Leaves short, 2 to 4 cm. ($\frac{3}{4}$ to $1\frac{1}{2}$ in.) long generally in pairs; cones small, about the same length as the leaves, seeds large (about the size of a common white bean), edible. A tree or shrub found in the foothills south and west. 3. **Pinus edulis**[1]
  - b. Leaves longer, 4 to 12 cm. ($1\frac{1}{2}$ to $4\frac{3}{4}$ in.) long; in bundles of 2 or 3.
    - a′ Leaves usually about 10 cm. ($3\frac{7}{8}$ in.) long, but shorter in exposed situations; sometimes longer. Cones 6 to 9 cm. ($2\frac{3}{8}$ to $3\frac{1}{2}$ in.). A tree of foothills and river bluffs and extending to an altitude of 10,000 ft. 4. **Pinus scopulorum**
    - b′ Leaves 3 to 6 cm. ($1\frac{1}{4}$ to $2\frac{3}{8}$ in.) long; cones about same length as leaves. A tree of foothills and mountains, often forming pure forests at altitudes of 7,000 to 9,000 ft. 5. **Pinus murrayana**

Pinus aristata Engelm. Bristle-cone Pine

Rydberg, *Flora Colo.* 7; Coulter, *Manual* 432 (as *P. balfouriana*, var. *aristata*); Sargent, *Manual Trees of N. A.* 9.

Leaves in bundles of 4 or 5, dark green, 2.5 to 4 cm. long. Staminate flowers dark orange-red; carpellate dark purple. Cone 7 to 9 cm. long. Cone scales somewhat thin, each with a slender curved bristle about 6 mm. long. Seeds winged.

A bushy tree of small or medium size with the main trunk short, numerous strong branches starting rather low down. Bark thin, pale or milky white on small branchlets, dark gray or brown on the main trunk. Wood soft and not durable; specific gravity 0.5572. Sometimes used for fuel. Formerly much employed in central Nevada for mine timbers but the supply is now nearly exhausted.

Rocky and gravelly slopes at high altitudes in the mountains from central and southern Colorado to Utah, Nevada, southern California and Arizona.

[1] A related species, ***Pinus monophylla***, differing in having the leaves single, is reported in Rydberg's ***Flora of Colorado*** from Manitou. The species, is however, usually considered to range west of Colorado.

Pinus flexilis James. LIMBER PINE, ROCKY MOUNTAIN WHITE PINE

RYDBERG, *Flora Colo.* 8 (as *Apinus flexilis*); COULTER, *Manual* 431; SARGENT, *Manual Trees of N. A.* 7; NELSON, *Key to Rocky Mountain Flora* 6.

Leaves in bundles of 5; stout, rigid, dark green, 3.5 to 7.5 cm. long. Staminate flowers reddish, the carpellate bright red-purple. Cone very large, 7 to 25 cm. long. Cone scales smooth, without bristle points. Seeds with a narrow wing which usually adheres to the cone scale when the seeds drop.

A small or medium-sized tree with a short main trunk and abundant lateral branches, growing in wind-swept situations and hence often much distorted. Bark of twigs and branches pale gray or whitish, becoming dark brown on older trunks. Wood light; specific gravity 0.4358; sometimes used for lumber which is, however, full of knots. This species was discovered in 1820 by Dr. Edwin James, of Major Long's exploring party, near the base of Pike's Peak.

Eastern slope of Rocky mountains from Alberta to western Texas, westward through Montana to Nevada and California. It is the principal tree of the upper foothills of the eastern slope in Montana. In Nevada it forms extensive forests. In Colorado and Wyoming it is usually scattered in exposed situations at rather high altitudes.

The limber pine has not been extensively planted as an ornamental tree but has done well where tried. In cultivation it has a handsome, rather symmetrical form.

Pinus edulis Engelm. PINYON, NUT PINE[1]

RYDBERG, *Flora Colo.* 8 (as *Caryopitys edulis*); COULTER, *Manual* 432; SARGENT *Manual Trees of N.A.* 11; NELSON, *Key to Rocky Mountain Flora* 5.

Leaves in bundles of 2, rarely 3; dark green, curved, stiff, 2 to 4 cm. long. Flowers dark red; the staminate in elongated clusters, the carpellate short stalked. Cone when mature about the same length as the leaves and nearly spherical; cone scales few, thick, spiny tipped. Seeds large, about the size of a small white bean, the narrow wing of the seed remaining adherent to the cone scale when the seed falls.

A small or medium-sized tree, much branched and shrublike. Bark rather thin; that of young branchlet's orange colored, becoming at length gray or brown. Wood rather durable; specific gravity 0.6388; brittle, close grained. Used for fuel and fencing and sometimes for preparation of charcoal. In western Texas it has been sawed for lumber. The large, edible seeds, collected by Indians, are on sale by fruit dealers in the towns and cities of Colorado.

Eastern foothills of the outer range of the Rocky Mountains from near the Palmer Lake divide south to western Texas and west to Arizona and southwestern Wyoming. At the head of the Arkansas it forms open forests with the rock pine; mixed

[1] The author is indebted to Professor E. A. Kenyon, of Florence, Colo., for fresh material of this species from which photographs were made.

with junipers it is common on the hills and table lands of western Colorado. It does not occur at very high altitudes.

Pinus scopulorum (Engelm.) Lemmon. ROCK PINE, WESTERN YELLOW PINE

RYDBERG, *Flora Colo.* 7; COULTER, *Manual* 432 (as *P. ponderosa*, var. *scopulorum*); SARGENT, *Manual Trees of N. A.* 15 (as *P. ponderosa*, var. *scopulorum*); NELSON, *Key to Rocky Mountain Flora* 6.

Leaves in bundles of two or three, variable as to number even on the same tree; stout, dark yellowish-green, often in bottle-brush arrangement at the ends of naked branches; 8 to 15 cm. long. Staminate flowers yellow; carpellate dark red. Cone 6 to 9 cm. long, the cone scales each with a stout sharp prickle. The young cones are erect the first summer; when fully grown they are horizontal or slightly declining.

A handsome spreading tree, the largest of our pines, with thick deeply-furrowed, reddish bark becoming very thick on old trees. Wood hard and strong but differing greatly in quality; where abundant it is sawed into lumber or used for railway ties and mine timbers. The specific gravity is 0.4619.

Hills and ridges of western Nebraska to Rocky Mountain region and from Montana to Arizona and New Mexico, forming on the Colorado plateau the most extensive pine forests of the continent.

On account of its resistance to drought this tree should be a valuable one for planting in semi-arid districts. The large seeds germinate freely and the trees are easily grown when given reasonable care.

Pinus murrayana "Oreg. Com." LODGEPOLE PINE

RYDBERG, *Flora Colo.* 8; COULTER, *Manual* 433 (as *P. contorta*, var. *murrayana*); SARGENT, *Manual Trees of N.A.* 27 (as *P. contorta*, var. *murrayana*); NELSON, *Key to Rocky Mountain Flora* 5.

Leaves in bundles of 2, yellow-green, 3 to 6 cm. long. Staminate flowers orange-yellow, carpellate reddish. Cone about the same length as the leaves, very persistent, often remaining attached three or four years after ripening; cone scales with short, sharp prickles. Seeds winged.

A tall, straight tree, generally growing in dense groves on north slopes in the foothills. The trees have been considered of little value for lumber but they are certainly most useful in holding the soil and in protecting snow from too rapid melting. Seeds of this pine, unlike those of most species, retain their vitality for a number of years. Burned districts become reseeded by the opening of the cones which takes place on account of the heat produced by the fire. Wood rather light and soft, not durable; specific gravity 0.4096. Used to some extent for ties, mine timber and fuel when better wood is not available. Recently developed methods of seasoning and preservative treatment promise to make the lodgepole pine valuable for railway ties and mine timbers.

Montana to southern Colorado, west to California and north to Alaska. This tree is found, as a rule, at higher elevations than the rock pine.

Genus **PICEA**, The True Spruces

Tall, conical, evergreen trees with tapering trunk and thin, scaly bark. Leaves needle-shaped, four-angled or flattened (ours four-angled) with sharp points. The leaves extend out from all sides of the twig in bottle-brush fashion; they are not in bundles as in pine but occur singly. Leaves jointed near the base, the lower part (sterigma) becoming woody and persistent after the fall of the leaf. Bare twigs thus appear roughened with short, truncate elevations. The stomata (pores) on the leaf surface may be seen with a good hand lens as white dots occurring in rows. Staminate flowers axillary; the carpellate terminal. Cones pendulous, the cone scales somewhat papery when mature. About 18 species all in the colder and temperate parts of the northern hemisphere. Various species are planted for ornament, or as windbreaks in exposed places.

Key to the Colorado Species of Picea

A. Leaves rigid, needle pointed, blue-green or silvery, branchlets smooth or at least not hairy. Cones about 7 cm. (2¾ in.) long. Frequent in cultivation. 1. **Picea parryana**

B. Leaves less rigid, abruptly pointed, having a somewhat skunk-like odor when bruised. The branchlets are generally described as pubescent but are smooth in specimens grown at high altitudes. Cones about 4 cm. (1⅝ in.) long. 2. **Picea engelmanni**

Picea parryana (Andree) Sarg. Blue Spruce, Colorado Blue Spruce

Rydberg, *Flora Colo.* 8; Coulter, *Manual* 431 (as *Picea pungens*); Sargent, *Manual Trees of N.A.* 44; Nelson, *Key to Rocky Mountain Flora* 6.

Leaves stout, rigid, four-angled, mostly 25 to 30 mm. long but on cone-bearing branches shorter and curved. Generally the leaves stand out from all sides of the branchlets but sometimes the under surface of horizontal branches has few leaves. Stomata (pores) in 4 to 7 rows on each of the four surfaces of the leaf. Color of leaves generally silvery or bluish-green when young, becoming duller with age. Individual specimens differ greatly in this regard. Cones about 7 cm. long; the cone scales rhomboid; corrugated; rounded or truncate at apex or sometimes with a few teeth.

A tree of medium size. Until the age of 30 or 40 years it forms a broad-based pyramid but later the lower branches die and the top may become ragged with branches rather far apart. Bark broken into small oblong, platelike scales; on old trunks thick and deeply grooved. Wood light, soft, weak; specific gravity 0.3740.

Along the mountain streams of eastern Colorado, west to Utah and north to the Wind River Mountains of Wyoming, occurring singly or in small groves.

Much cultivated for ornament in this country and in Europe. There are numerous horticultural varieties propagated by grafting.

Picea engelmanni (Parry) Engelm. ENGELMANN SPRUCE

RYDBERG, *Flora Colo.* 8; COULTER, *Manual* 431; SARGENT, *Manual Trees of N.A.* 43; NELSON, *Key to Rocky Mountain Flora* 6.

Leaves ridged above and below so that they are rather four-sided; awl pointed; not so stiff as those of the blue spruce. Leaves at first covered with a bluish or silvery bloom which disappears later; slender, 25 to 30 mm. long on the ordinary branches but shorter on cone-bearing twigs; stomata in 3 to 5 rows on each of the four surfaces of the leaf. Cones 3 to 5 cm. long, the cone scales truncate or acute at tip, sometimes toothed.

A large conical tree of the higher foothills and mountains; near timber limit a straggling, prostrate shrub. Bark thin, broken into large, thin, loose scales. Wood light, soft, close grained, not strong; specific gravity 0.3449. Frequently used for lumber and for making charcoal. The bark has been employed for tanning leather. In some localities the Engelmann spruce has been largely cut for railway ties and to some extent for telegraph and telephone poles. It should be valuable for wood pulp.

In the Cascade, Selkirk and Rocky Mountain ranges of British Columbia and Alberta, south through the mountain states to New Mexico and Arizona, west to Oregon. It is by far the more abundant of our two species of *Picea* and is the common tree near timber line where it forms scrubby mats. In such situations it seldom bears cones.

The Engelmann spruce has been planted for ornament in the eastern United States and in Europe. Sometimes it is mistaken for the blue spruce. These two species of Picea are not easily distinguished; however, the size of the cones is usually a marked feature. In addition the number of rows of stomata on the leaves and the character of the bark should be noted. The leaves of the blue spruce are distinctly stiffer than those of the Engelmann spruce.

Genus **PSEUDOTSUGA**, DOUGLAS SPRUCE

Tall, conical, evergreen trees with thick, furrowed bark and strong wood resembling in quality that of the best hard pines. Branches horizontal or ascending with a somewhat more feathery appearance than the true spruces. Leaves linear, flat; with a short leaf-stalk; the face of the leaf grooved above and with a prominent midrib below. Stomata (pores) on the under surface. Flowers solitary, appearing early in spring; the staminate scattered along the branches, small, oblong-cylindrical; the carpellate reddish-purple, borne near the tips of upper branches, easily seen from a distance. Cones pendulous, cone scales persistent; bracts with prominent teeth giving the cone a fringed appearance. Three species of this genus are known; one in Japan, the other two in western North America. One of these latter occurs in Colorado.

Pseudotsuga mucronata (Raf.) Sudw. DOUGLAS SPRUCE, RED FIR

RYDBERG, *Flora Colo.* 8; COULTER, *Manual* 431 (as *Pseudotsuga douglasii*); SARGENT, *Manual Trees of N.A.* 53; NELSON, *Key to Rocky Mountain Flora* 6 (as *Pseudotsuga taxifolia*).

Leaves rather soft, not rigid, flat, channeled above and ridged below, 20 to 35 mm. long, dark yellow-green in color, narrowed to a short stalk; leaf scars not prominent. Cones pendulous, 5 to 10 cm. long, the bracts projecting beyond the scales. Each bract with two lateral teeth and the midrib projected as a rigid awn.

A tree of handsome conical form, especially when young; reaching the greatest size in the moist forests of Oregon and Washington. Bark on young trees smooth and thin; on older trees very thick and deeply furrowed; sometimes used in tanning. Wood hard; light red or yellow; specific gravity 0.5157; largely manufactured into lumber in the Pacific Northwest where it is generally known as "Oregon pine" or as "red fir." Used also for fuel, railway ties and piles.

British Columbia and Alberta southward through hills and mountains to northern Mexico and western Texas.

Frequently planted as an ornamental and shade tree in Europe and the eastern United States. Numerous varieties are distinguished in cultivation. It is propagated easily from seed and has been recommended for reforesting of cut-over timber lands in the central Northwest.

Genus ABIES, THE FIRS, BALSAMS

Tall, conical trees of colder regions and mountain districts; with linear, flat, sessile leaves, grooved above and having a notched apex. Although developed on all sides of the branches the leaves generally bend so as to form flat masses of foliage. On the upper cone-bearing branches the leaves are often curved and thick, with the upper surface convex instead of grooved. Branches developed on the main trunk in regular whorls; the branchlets show rather prominent circular scars where the leaves have fallen. Flowers produced in early spring, the staminate flowers numerous on the under sides of branches in the upper part of the tree; carpellate flowers chiefly on the upper sides of topmost branches. Cones erect, purplish-black or yellow, formed of closely imbricated scales; exuding a balsamic resin. The cone scales and bracts separate from the axis while this is still on the tree. Hence complete cones are never found under the trees but only scales and seeds.

About 25 species are known of which 9 occur in North America. The best known fir is *Abies balsamea* of the northeastern states and Canada. In this species distinct balsam blisters are found in the bark which contain the substance known as "Canada balsam." Only two species of Abies are known in Colorado.

Key to the Species of Abies in Colorado

A. Leaves of vigorous lower branches 2.5 to 4.5 cm. (1 to 1¾ in.) long; resin ducts of the leaves deeply imbedded, not close to the epidermis. Cones purple or nearly black. 1. **Abies lasiocarpa**

B. Leaves of vigorous lower branches 4.5 to 7.5 cm. (1¾ to 3 in.) long; resin ducts of the leaves close to the epidermis of the under surface; cones yellow, green or purple. Not found in northern Colorado. 2. **Abies concolor**

Abies lasiocarpa (Hook.) Nutt. Alpine Fir

Rydberg, *Flora Colo.* 9; Coulter, *Manual* 430 (as *Abies subalpina*); Sargent, *Manual Trees of N.A.* 61.

Leaves flat, with prominent mid-vein, bluish-green; on vigorous lower branches 2.5 to 4.5 cm. long; on old parts and on cone-bearing twigs much shorter. Cone oblong-cylindrical, rounded, erect, purple or nearly black, 6 to 10 cm. long.

A medium sized tree with branches extending nearly to the base of the trunk; bark of young trees pale gray and smooth; on old trees broken with shallow fissures and roughened with thin orange-colored scales. Wood light, not strong, nor durable; of little value but sometimes used as firewood; specific gravity 0.3476.

High altitudes in the mountains throughout western North America.

This species is sometimes planted as an ornamental tree in the northern United States and in central Europe.

Abies concolor Lindl. White Fir

Rydberg, *Flora Colo.* 9; Coulter. *Manual* 430; *Sargent*, *Manual Trees of N. A.* 62.

Leaves mostly in two rows on the branchlets, more or less erect; on lower branches flat, straight, with rounded or pointed apex; length 4.5 to 7.5 cm.; on cone-bearing twigs shorter and generally curved. Cone ellipsoid-cylindrical, 7 to 13 cm. long, grayish-green, purple or yellow, with broad, closely imbricated scales. A large tree with narrow spirelike crown; the short, main branches bearing long, lateral branchlets; the whole forming frondlike masses of foliage. Bark of old trunks becoming very thick, deeply divided into broad, rounded ridges. Wood light, close grained, not strong nor durable; specific gravity 0.3638.

From the Pike's Peak region of the Rocky Mountains of Colorado west to Oregon and south to northern Mexico and Arizona reaching its greatest development in the Sierras of California. It is the only true fir in the arid regions of the great Basin.

This tree has been planted for ornament in some places and promises to be useful.

Volume IV Number 3

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CONTENTS

A THEOREM ON DIFFERENTIAL FUNCTIONS

By S. Epsteen

In the theory of Algebraic Equations[1] it is shown that every rational symmetric function of the roots of an algebraic equation can be expressed rationally in terms of the coefficients. As a corollary of this Professor James Pierpont proves in Part I of his lectures on "Galois Theory of Algebraic Equations:"[2] Let R be a given domain of rationality and

$$f(x)=x^n+a_1x^{n-1}+a_2x^{n-2}+a_3x^{n-3}+\ldots a_{n-1}x+a_n=0\,,$$

an equation whose coefficients lie in R. Let its roots be $\xi_1, \xi_2, \ldots, \xi_n$. Then an integral rational symmetric function of $n-1$ of the roots, say $\xi_2, \xi_3, \ldots, \xi_n$, is an integral rational function of the remaining root ξ_1.

In the Theory of Linear Differential Equations it is shown[3] that a rational symmetric differential function of the integrals of a fundamental system $y_1 \ldots y_n$ can be expressed rationally in terms of the coefficients and their derivatives. Let R be a given domain of rationality and

$$Py=\frac{d^ny}{dx^n}+p_1\frac{d^{n-1}y}{dx^{n-2}}+\ldots+p_{n-1}\frac{dy}{dx}+p_ny=0,$$

a linear homogeneous differential equation with coefficients in R. Then as a corollary of Appell's Theorem we show (in analogy with the Theory of Algebraic Equations) that: *An integral rational symmetric differential function of $(n-1)$ solutions, say $y_2 \ldots y_n$, is an integral rational function of $\eta=\frac{y_1'}{y_1}$* and its derivatives, y_1 being the remaining solution.

The differential equation $Ly=\frac{dy}{dx}-\eta y=0$ has for a solution $y=y_1$.

[1] Burnside and Panton, Vol. I, Art. 78. (Fourth edition, 1899.)

[2] *Annals of Mathematics*, 2d Series, Vol. I, No. 4 (1899–1900), p. 116, Art. 3.

[3] Appell, *Annales de l'École Normale Supérieure*, Series II, Vol. X (1881), p. 400. See Schlesinger, *Handbuch der Theorie der linearen Differentialgleichungen*, Vol. I, Part 1, p. 41

Let

$$Qy=\frac{dy^{n-1}}{dx^{n-1}}+q_1\frac{dy^{n-2}}{dx^{n-2}}+\dots\dots+q_{n-1}y=0$$

be a differential form such that, in the symbolic notation of Boole,

$$QLy=Py\,. \tag{1}$$

Evidently $y_2 \dots\dots y_n$ is a fundamental system of the equation $Qy=0$.

The equation $Py=0$ being irreducible, the coefficients $q_1 \dots\dots q_{n-1}$ are not in the domain R. Indeed, by performing the operations indicated in (1) and comparing coefficients there results:

$$p_1=q_1\eta\,,\qquad p_2=q_2-q_1\eta-(n-1)\eta',$$

$$p_3=q_3-q_2\eta-(n-2)q_1\eta'-\frac{(n-1)(n-2)}{2\,!}\eta'',\quad \text{etc.},$$

whence we obtain:

$$q_1=p_1+\eta\,,\qquad q_2=p_2+p_1\eta+\eta^2+(n-1)\eta'',$$

$$q_3=p_3+p_2\eta+p_1(\eta^2-\eta')+\eta^3+n\eta\eta'+\frac{(n-1)(n-2)}{2\,!}\eta'',\quad \text{etc.}$$

It is thus seen that the coefficients are rational in terms of $p_1 \dots\dots p^n$; η, η', η'', ...[1]

By Appell's Theorem, an integral rational symmetric differential function of the solutions $y_2 \dots\dots y_n$ of $Qy=0$ is rational in the q's and their derivatives. Therefore it is rational in $p_1, \dots\dots, p_n$, η, and their derivatives.

[1] Indeed, if

$$Ty=\frac{d^my}{dx^m}+t_1\frac{d^{m-1}y}{dx^{m-1}}+t_2\frac{d^{m-2}y}{dx^{m-2}}+\dots\dots t_my=0$$

has m integrals in common with $Py=0$, then

$$Qy=\frac{dy^{n-m}}{dx^{n-m}}+q_1\frac{dy^{n-m-1}}{dx^{n-m-1}}+\dots\dots+q_{n-m}y=0$$

can be determined such that $QTy\equiv Py$. The coefficients t of T are in domain R. The coefficients q can be determined rationally in terms of the p's and t's. This computation was made by Miss Ruby L. Carstens who finds

$$q_1=p_1-t_1\,,\qquad q_2=p_2+p_1t_1-t_1^2-mt_1'-t_2\,,$$

$$q_3=p_3-p_2t_1+p_1(t_1^2-t_2-mt_1'+t_1')+2t_1t_2+mt_1t_1-t_3^1+t_1t_1'(m-1)-t_3-(m-1)t_2'-\frac{m(m-1)}{2}t_1'',\quad \text{etc.}$$

The corresponding theorem where, instead of a domain of rationality, one takes a monotopic domain (i. e., a domain in which the coefficients are single valued) is given in SCHLESINGER's *Handbuch*, Vol. I, pp. 45, 46.

ON AN ALGEBRA IN THREE UNITS

By S. Epsteen and Harry V. Welch

§ 1. Historical

Suppose that one is familiar with the arithmetic of positive integers only. In that case the equation $ax=b$ (a and b, positive integers) would, in general, not be solvable. In the domain of positive integers and fractions this equation would be solvable, whereas the equation $a+x=b$ would, in general, not be. Both of these equations can be solved if the domain is enlarged by the adjunction of negatives. In order to solve the equation $x^n=a$ (n, a, positive integers) the latter domain must be further extended by the introduction of the irrational number. Let us designate the final domain thus obtained by $R(1)$. The developments in algebra prior to the nineteenth century are characterized by the fact that *they were studies of the domain* $R(1)$. The equation $x^2=-1$ is not solvable in this domain and its root, $i=\sqrt{-1}$, was said to be imaginary, i.e., exterior to the domain $R(1)$. Through the publications of Argand and Gauss, at the close of the eighteenth century and beginning of nineteenth, the properties of this new unit became known to the mathematical world and for the next half-century mathematicians studied the algebra of the units $1, i$, that is, the so-called complex algebra. Therefore, we may say: *during the first half of the nineteenth century the progress in algebra consisted in complete discussion of the domain* $R(1, i)$.[1]

The fundamental theorem of these investigations is due to Gauss: the equation $a_0x^n+a_1x^{n-1}+\ldots a_n=0$ (n positive integer, a_1, a_2, $\ldots a_n$ belonging to $R(1, i)$ has at least one root belonging to $R(1, i)$.[2]

[1] Historically, the real number system including positive integers and fractions was known to the Egyptians, over 1700 B. C. The irrational numbers were discovered by the Greeks as a corollary of the theorem of Pythagoras. To the Hindoos belongs the credit of inventing the zero, about the fifth century A. D., in consequence of which negative numbers were discovered. In 1806 Argand made public a method of representing $i=\sqrt{-1}$ geometrically, thus completing the number system of algebra.

[2] This is the so-called fundamental theorem of algebra.

In order not to interrupt the argument which will follow, we point out here that the unit of the domain $R(1)$ has the multiplication table,

$$\begin{array}{c|c} & e_1 \\ \hline e_1 & e_1 \end{array}$$

e_1 having the ordinary properties of unity. The units of the domain $R(1, i)$ have the multiplication table

$$\begin{array}{c|cc} & e_1 & e_2 \\ \hline e_1 & e_1 & e_2 \\ e_2 & e_2 & -e_1 \end{array}$$

where e_1 has the properties of unity, e_2 the properties of $i = \sqrt{-1}$.

The general number of the latter algebra is $a_1e_1 + a_2e_2$, where a_1 and a_2 are reals.

Since all the numbers of the domain $R(1)$ are represented graphically by the totality of points on a straight line and all the numbers $a_1 + ia_2$ of the domain $R(1, i)$ are represented by the totality of points of a plane, one might infer that the totality of points in space is the geometric representation of some algebra in three units. Proceeding on this thought Hamilton attempted to set up a three-unit system e_1, e_2, e_3 which would have this property. In the introduction to his *Quaternions* he proved that no such system exists when the coefficients a_1, a_2, a_3, of the general number $A = a_1e_1 + a_2e_2 + a_3e_3$ belong to the domain of reals $R(1)$. His proof consists in showing that any algebra in three units, the coefficients belonging to $R(1)$, contains numbers $x = x_1e_1 + x_2e_2 + x_3e_3$ and $y = y_1e_1 + y_2e_2 + y_3e_3$, both different from zero, for which the product $xy = 0$.

As Benjamin Peirce points out in his memoir on "Linear Associative Algebra,"[1] Hamilton's investigation should be made in the field of complex numbers instead of in the field of real numbers. In other words, the coefficients a_1, a_2, a_3, of the number $A = a_1e_1 + a_2e_2 + a_3e_3$ should be considered as belonging to the domain $R(1, i)$ rather than to the domain $R(1)$.

The problem of the present paper consists in carrying out Peirce's thought for one interesting algebra in three units e_1, e_2, e_3. The algebra

[1] *American Journal of Mathematics*, Vol. IV (1882), p. 9. footnote.

in question is assumed to have the property that when e_3 is deleted the remaining units e_1, e_2 will form the ordinary complex algebra. That is to say, it has, in part, the multiplication table:

$$\begin{array}{c|cc} & e_1 & e_2 \\ \hline e_1 & e_1 & e_2 \\ e_2 & e_2 & -e_1 \end{array}$$

It is assumed that e_1 is the *unity* or *modulus* for our algebra, i. e., $e_1e_3 = e_3e_1 = e_3$. The multiplication table may, therefore, be written:

$$(1)\qquad \begin{array}{c|ccc} & e_1 & e_2 & e_3 \\ \hline e_1 & e_1 & e_2 & e_3 \\ e_2 & e_2 & -e_1 & p_{231}e_1+p_{232}e_2+p_{233}e_3 \\ e_3 & e_3 & p_{321}e_1+p_{322}e_2+p_{323}e_3 & p_{331}e_1+p_{332}e_2+p_{333}e_3\,. \end{array}$$

We assume, moreover, that this algebra has in common with ordinary algebra the property that all its numbers are commutative. In particular, then, $e_2e_3 = e_3e_2$ and therefore:

$$(2)\qquad \begin{aligned} p_{321}&=p_{231} \\ p_{232}&=p_{322} \\ p_{233}&=p_{323}\,. \end{aligned}$$

It will be shown *that the desired algebra has the multiplication table:*

$$\begin{array}{c|ccc} & e_1 & e_2 & e_3 \\ \hline e_1 & e_1 & e_2 & e_3 \\ e_2 & e_2 & -e_1 & ae_1+iae_2+ie_3 \\ e_3 & e_3 & ae_1+iae_2+ie_3 & be_1+(ac-ia^2-ib)e_2+ce_3, \end{array}$$

a, b, c, being any quantities in the domain $R(1, i)$; and also that this algebra is reducible.

§ 2. The Multiplication Table of the Algebra

I. Besides modifying the multiplication table (1) in accordance with the commutative law [i. e., introducing the equalities (2)] account must be taken of the associative law

$$e_ie_j \cdot e_k = e_i \cdot e_je_k\,.$$

The associative condition,

$$(3)\qquad e_2e_2 \cdot e_3 = e_2 \cdot e_2e_3$$

gives the identity,

(4) $$-e_3=p_{231}e_2-p_{232}e_1+p_{233}(p_{231}e_1+p_{232}e_2+p_{233}e_3)\,.$$

Equating coefficients of e_1, e_2, e_3, there result:

(5) $$-p_{232}+p_{233}p_{231}=0\,,$$

(6) $$p_{231}+p_{233}p_{232}=0\,,$$

(7) $$p_{233}p_{233}=-1\,.$$

From (7),

(8) $$p_{233}=\sqrt{-1}=i\,,$$

and it is easily seen that (5) and (6) are both equivalent to the single relation

(9) $$p_{232}=ip_{231}\,.$$

The associative condition,

(10) $$e_2e_3\cdot e_3=e_2\cdot e_3e_3\,,$$

and the relations of commutativity, give the identity

$$p_{231}e_3+ip_{231}(p_{231}e_1+ip_{231}e_2+ie_3)+i(p_{331}e_1+p_{332}e_2+p_{333}e_3)$$
$$=p_{331}e_2-p_{332}e_1+p_{333}(p_{231}e_1+ip_{231}e_2+ie_3)\,.$$

Equating coefficients of e_1, e_2, e_3,

(11) $$ip_{231}^2+ip_{331}=-p_{332}+p_{333}p_{231}\,,$$

(12) $$-p_{231}^2+ip_{332}=p_{331}+ip_{333}p_{231}\,,$$

each of which gives,

(13) $$p_{332}=p_{333}p_{231}-p_{231}^2-ip_{331}\,.$$

Let:

(14) $$p_{231}=a\,,\quad p_{331}=b\,,\quad p_{333}=c\,,$$

a, b, c, being any numbers in the domain $R(1, i)$.

In view of (2), (8), (9), (13), (14), the multiplication table of the algebra takes the form:

(15)

	e_1	e_2	e_3
e_1	e_1	e_2	e_3
e_2	e_2	$-e_1$	$ae_1+iae_2+ie_3$
e_3	e_3	$ae_1+iae_2+ie_3$	$be_1+(ac-ia^2-ib)e_2+ce_3$.

II. As stated at the end of § 1 this algebra is reducible.[1] Making the following transformations upon the units:

$$
(16)\qquad
\begin{aligned}
e_1' &= \frac{e_1+ie_2}{2} \\
e_2' &= \frac{e_1-ie_2}{2} \\
e_3' &= x_1e_1+x_2e_2+x_3e_3
\end{aligned}
$$

$$\left(\text{where,}\quad x_3=\frac{x_2+ix_1}{a}\right),$$

the multiplication table takes the form:

	e_1'	e_2'	e_3'
e_1'	e_1'	0	0
e_2'	0	e_2'	e_3'
e_3'	0	e_3'	$ke_2'+le_3'$,

in which

$$k=\frac{2}{a}[b(x_2+ix_1)^2-cx_1(x_2+ix_1)+a(x_2^2-x_1^2)]\,,$$

$$l=2i(x_2-ix_1)+\frac{c}{a}(x_2+ix_1)\,.$$

[1] For the definition of reducibility see EPSTEEN, *Transactions of American Mathematical Society*, Vol. V, pp. 106–9.

THE APPEAL OF ALEXIUS FOR AID IN 1095

By Edward Tuthill

Many historians affirm that the immediate occasion, if not the cause, of the First Crusade was an appeal by the Eastern Emperor, Alexius I, to Pope Urban II for aid against the Turks, who were said to be threatening the city of Constantinople with destruction. The most convenient and comprehensive version of this story appears in Gibbon's great work; and an excerpt is given here because it reflects present tendencies in our textbooks and reference works. At the Council of Placentia, which was held in March, 1095—

> The ambassadors of the Greek emperor, Alexius Comnenus, were introduced to plead the distress of their sovereign, and the danger of Constantinople, which was divided only by a narrow sea from the victorious Turks, the common enemy of the Christian name. In their suppliant address they flattered the pride of the Latin princes; and, appealing at once to their policy and religion, exhorted them to repel the barbarians on the confines of Asia rather than to expect them in the heart of Europe. At the sad tale of the misery and perils of their Eastern brethren, the assembly burst into tears; the most eager champions declared their readiness to march; and the Greek ambassadors were dismissed with the assurance of a speedy and powerful succor. The relief of Constantinople was included in the larger and most distant project of the deliverance of Jerusalem; but the prudent Urban adjourned the final decision to a second synod, which he proposed to celebrate in some city of France . . . .[1] [i.e., Clermont].

The purpose of this study is to show that the evidence for this famous appeal is very slight; that many chroniclers in Italy and France who heard about the council omit this incident; that the Crusaders, also, were apparently unaware of it; and that the eastern empire, according to our best authorities, had no occasion to seek aid in 1095 because the Turks were then engaged in fierce civil wars. We shall take up these points in order.

Little Evidence to Support This Appeal

Only one chronicler strictly contemporary[2] with the event described gives definite information about this appeal. This is Bernold of Con-

[1] Gibbon, *Decline and Fall*, chap. lviii.

[2] Otto of Freising, *Chronicon*, VII, c. 2; Gislebert de Mons, *Chron. Hannoniae* (ed. Arndt), p. 56; Benedictus Accoltus, circa 1470; and Guillaume Aubert, of the sixteenth century, add nothing to the earlier narratives, and are not contemporary.

stance, whom historians generally accept as entirely trustworthy. He was, however, a violent partisan of Urban and Gregory in the Investiture Strife.[1] He would therefore be inclined to magnify the prestige of Urban II as against Guibert the anti-Pope whenever an opportunity presented itself. But it is a significant fact that Bernold nowhere indicates that he was an eyewitness of the presentation of the Greek envoys, nor even that he was present at the council itself.[2] These considerations alone suggest the exercise of much caution before accepting the full account so freely rendered by Gibbon from Bernold's chronicle.

Moreover, our caution gives rise to serious doubts when we examine the testimony of another writer who, unlike Bernold, is known to have been present at the council. This was Donizo, the friend and biographer of Countess Matilda of Tuscany, who accompanied Urban to the council. Donizo was attached to the retinue of the Countess and thus enjoyed exceptional opportunities as a news-gatherer in diplomatic circles. Several events, such as Guibert's heresies, the conduct of Praxedis, and other public business, engaged his attention and are recorded in his *Life of Matilda*[3] but the appeal by the Emperor, which was in all respects the most impressive event that could possibly occur on this occasion, he utterly ignores. The eastern empire is nowhere mentioned as a subject of discussion, much less the taking of oaths by Crusaders to support that empire. Donizo's brief but valuable statements possess as much virtue as Bernold's and should be used for the same purpose. He could have no discernible motive in suppressing such an event.

What We Learn from Chroniclers in Italy and France

In the same account Bernold maintains that the council consisted of more than thirty-four thousand persons, including bishops from Italy, France, Burgundy, Swabia and Bavaria. After making a liberal allowance for exaggeration—because only large figures could impress the

[1] See Potthast, *Wegweiser durch Mittelalter* . . . . for list of his controversial writings.

[2] When he says, "Missas quoque nonnunquam extra ecclesiam satis probabiliter, necessitate quidem cogente, celebramus," he is merely justifying the celebration of mass in the open air, sometimes permitted by the Church.

[3] Donizo, *Vita Mathildis*, in Migne, *Patrol. Lat.*, cxlviii, 1015. The biography as a whole is poor, as Wattenbach has justly observed (*Quellenkunde*, 5. Auf., II, 215). On the other hand, Donizo remembered this council distinctly—"quam saepe recordor," he says.

medieval man—there should remain a sufficient number of eyewitnesses to herald the acts of the council throughout Western Europe. For, when all these churchmen returned home, they were compelled by the conditions of medieval travel to tarry for food and rest at numerous monasteries—the hotels of the Middle Ages; ecclesiastics from Salzburg, Passau, Constance and other distant cities would be guests in many places where courtesy would require a full answer to the inquiring abbot or chronicler who wished to learn the acts of the council. Indeed, the intimate bond existing between the papacy and the monks created an intense interest in every incident affecting the progress of the true Pope as against the anti-Pope. Had the eastern Emperor "humbly implored the Pope and all the Faithful," as Bernold alone asserts, the good news could not have been concealed from so many chroniclers who heard something about this council but who record nothing about an appeal from the East.[1]

From Placentia Urban and his retinue proceeded by easy stages into France, dedicating churches by the way and meeting various bishops.[2] At Clermont he delivered the famous exhortation which induced so many thousands to take the cross. This oration was reported by a group of writers[3] who thus had ample opportunity to learn all the important acts of the previous council. With such facilities at hand, all but one of these writers omitted Placentia, and the one exception—Baldric of Dol—remembered that it was a "general synod." This result is the more striking because each writer alludes briefly to the origin of the Crusade. Urban himself seems to have made no allusion to Placentia, and it is plain that these contemporaries, like their brethren in Italy, did not think of such an appeal as Bernold alone records. It is equally plain, however, that complaints of the eastern Christians were abundant throughout this period. The Pope reminded his hearers of the frequent tales of misery brought from Jerusalem, Constantinople and the East;[4]

[1] Besides those cited above, see PANDULF OF PISA in *Muratori*, III, p. 352; ORDERICUS VITALIS, lib. IX, c. i: "Urbanus papa Placentiae concilium tenuit, et de pace aliisque utilitatibus sanctae Ecclesiae diligenter tractavit." GAUFREDUS MALATERRA has no record of it.

[2] See Urban's itinerary in JAFFE'S *Regesta* (1885).

[3] ROBERT THE MONK, BALDRIC, and probably FULCHER and GUIBERT; see *American Historical Review*, Vol. XI, pp. 232, 233.

[4] *Recueil des Historiens des Croisades*, III, 323; 727; also IV, 12–13.

Baldric says refugees were often seen;[1] Ekkehard of Aurach saw in the Holy Land in 1101 copies of appeals by the eastern churches to western Christians.[2] To explain Bernold's error, then, we may assume that he heard something about a delegation from the East seeking aid. As it came through, or even from, Constantinople, he hastily concluded that it was an imperial embassy.

Two chroniclers sometimes cited as confirming Bernold are the Italian called Lupus Protospatarius and the anonymous author of the annals of Jumièges (*Annales Gemmaticenses*). The former records a brilliant display of meteors in April, 1095 and adds: "And afterwards the people of Gaul, yea of all Italy, began to march to the Sepulchre of the Lord with their arms and with a cross on the right shoulder."[3] It requires a number of assumptions to show that this notice has any connection with an appeal at Placentia. The people of Gaul did not start until after the Council of Clermont in November, and probably the author—whose identity and name are unknown—meant nothing more than to associate the meteors with the subsequent crusade thus foreshadowed.[4]

The second notice mentioned above runs as follows: "In the same year [1095] Pope Urban who had held a council in Italy to encourage men to go to Jerusalem, held a second council at Clermont and commanded Christians to go to Jerusalem with crosses affixed to their garments."[5] This would be a very significant notice if it were contemporary; but it seems to be of late origin. Of the two manuscripts extant, that of Paris belongs to the fifteenth and that of the Vatican to the eighteenth century. A third manuscript, no longer extant, is said to have been incorporated in Sigebert's *Chronicon* but the latter does not allude to

[1] *Ibid.*, IV, 12: "Videbamus aliquando cives ipsius Jerusalem inter nos, mendicos et exulos; videbamus indigenos Antiochiae." Observe the imperfect tenses.

[2] *Hierosolymita* (ed. *Hagenmeyer*), V, c. 2: "Per legationes tamen frequentissimas et epistolas etiam a nobis visas universalem ecclesiam ecclesiae Hierosolymitanae in presidium lugubriter inclamantes."

[3] *Chronicon*, anno 1095: "De mense Aprilis in nocte quinta feria subito visi sunt igniculi cadere de caelo quasi stellae per totam Apuliam . . . . Et ex tunc (exterius) coeperunt Galliae populi pergere, immo totius Italiae, ad sepulchrum Domini cum armis ferentes in humero dextro crucis vexillum."

[4] Even in our own times the comet of 1861 was supposed to portend the Civil War.

[5] *M. G. SS.*, XXVI, p. 508: "Eodem anno Urbanus papa qui prius in Italia concilium tenuerat pro exhortatione Yerosolymitani itineris iterum apud Clarum Montem concilium tenuit et constituit, ut Christiani fixis crucibus in vestibus Ierusalem pergerent." Cf. also p. 489 and references. Cf. *Chron. Casin*, in *M. G. SS.* VII. 765.

any appeal for aid.[1] The next entry in the *Annales* after 1095 is a notice of Urban's death in 1099. Moreover, the authorship of this portion of the *Annales* is unknown and no allusions are made to Placentia or to the Eastern Empire.

The Crusaders and Their Historians

Yet another indication of the general ignorance of such an appeal as Bernold describes appears in the letters and chronicles written by the Crusaders in the East. Their indignation against Alexius waxed hot when they discerned that he was using them for his own purposes. They complained about many things. They even declared in a letter to Urban that Alexius had promised much and granted little, thus violating the agreement at Constantinople.[2] In all these complaints, however, there is no phrase accusing the Emperor of lack of hospitality to invited guests. The Crusaders did not suggest the claims of hospitality at Constantinople, nor do they recall any such promises when their sufferings ought to have provoked these charges as the very first accusation. Though a hundred thousand Crusaders[3] were directly concerned in this matter, they have left no record of it either in their extant letters or in the influence which they must undoubtedly have exerted, after their return, upon the writers of chronicles in the West.

Among the historians of this crusade two contemporaries deserve especial mention. One of these was Guibert of Nogent, a French abbot, who probably witnessed the Council of Clermont. Here he may have talked with members of Urban's retinue who had come from Italy. Some years later, after the capture of Jerusalem, Guibert decided to write a history of the expedition.[4] He gave it a famous title—*Gesta Dei per Francos*. While it is a valuable account, its author confesses his

[1] *M. G. SS.*, XXVI, p. 489, MS. S. Mariae de Voto. Sigebert's *Chronicon* mentions only the massacre of the Jews and the storming of Jerusalem in his account of the crusade.

[2] Consult numerous letters in HAGENMEYER, *Kreuzzugsbriefe*, especially that of the Leaders to Urban from Antioch, 1098; " . . . . tu vero nos filios, pater piissime, debes separare ab iniusto imperatore qui multa bona promisit sed minime fecit." Hence they ask to be absolved from their contract with Alexius. See HAGENMEYER, *ibid.*, 161 and 357.

[3] Some estimates exceed 300,000: SYBEL, *Gesch. des ersten Kreuz.*, 284, note.

[4] *Recueil des Hist. des Crois.*, IV, 120: "Nec diffiteor me post Iherosolym captionem, ex quo illi qui interfuerant expeditioni redire coeperunt, ad scribendum ea animum appulisse."

faults with respect to rhetorical display.[1] This besetting sin often obscures the truth. The narrative shifts quickly from prose to verse, and the involved sentence is not always precise. An excellent illustration of this tendency appears in Guibert's version of the appeals. He says Urban was moved by the gifts and entreaties of Alexius to come into France, but much more by the general dangers that threatened Christendom as a result of Saracen attacks from Spain.[2] He does not specify any appeal in particular, nor does he allude to any council in Italy. This in itself tends to show that he did not consider Placentia worthy of record in this connection; and the omission is the more striking because he devoted two books to the preliminaries of the crusade. He had previously recorded the letter of Alexius to his patron, Robert of Flanders, about 1088, and therefore knew that Alexius had sought aid. His allusion to gifts doubtless goes back to the appeals of 1082 and 1085, recorded by Anna Comnena,[3] the daughter of Alexius, an eyewitness of the First Crusade. At any rate, Guibert significantly employs the plural form—*precibus*—thus uniting all the earlier appeals. And, far from ascribing supreme importance to any one of them, he regards them all as inferior to such other factors as Urban's French training and Saracen raids from Spain. In this he is undoubtedly correct and modern historians ought to follow him rather than Bernold as a guide for the First Crusade.

The second historian who deserves examination is Ekkehard of Aurach, a German monk, whose *Chronicon Universale* contains much information on this period. We are fortunate in having both the earlier and later drafts of this work. In the earlier draft the entries for the years 1095, 1096, and 1097 show no knowledge of appeals for aid by Alexius and no prejudice against him.[4] But in 1101 Ekkehard went

[1] *Recueil*, IV, 118: Decet enim licetque prorsus operosa historiam verborum elegantia coronari. *Cf.* also THUROT in *Revue Historique*, II, 107.

[2] *Recueil*, IV, 135: "Is itaque vir eximius quum ab Alexi Graecorum principe magnis honoraretur exeniis, et precibus quidem, sed multo propensius generali Christianitatis periculo pulsaretur, quae quotidianis gentilibus minuebatur incursibus (Sarracenorum namque irruptionibus Hispanias audiebat saepissime conturbari) pro hoc ipso, suae gentis sollicitaturus homines, commeatum facere destinavit in Franciam."

[3] *Alexiad* (ed. *Reifferscheid*, 1884) lib. III, c. 10; lib. V, c. 3, 5; for the appeal of 1088 see lib. VI., c. 6, 7, 11. For an appeal about 1091 see lib. VIII, c. 5, and CHALANDON, *Essai sur le Règne d'Alexis Ier*, p. 129. These are all confirmed by one or more Latin writers.

[4] See text and readings in MIGNE's *Patrologia*.

to Jerusalem as a pilgrim. While in the East he saw and heard so many new things that he decided to rewrite the story of the crusade. Returning in 1102 by way of Rome, he carried out his resolution, and called the new work the *Hierosolymita*. In it he expresses the prejudices which he contracted while associating with the Crusaders.[1] In several places he applies harsh epithets to Alexius[2] although he had no personal grievances against him. Fortunately for our purpose, Ekkehard twice mentions appeals from the East. In chapter v, section 2 he says he saw circular letters asking for western help, as given above.[3] But in section 3 of the same chapter he says Alexius sent many letters to Urban, asking the entire Occident to hasten to his relief and promising the necessary supplies for all both on sea and land.[4] This extravagant rumor does not appear in any other writer, and Ekkehard carefully refrains from saying that he saw any of these letters in any form. He does not furnish any particulars about such letters, and we know that he could not have seen them at Rome.[5] Neither could he have learned of them from Urban, who died three years before Ekkehard visited Italy. He does not mention Placentia at all. What he gives he probably accepted because it harmonized with the common estimate of the character of Alexius. Long before 1102 it was perfectly plain that the Emperor had cleverly used the Crusaders for his own advantage; Raymond says the people hated him bitterly.[6] Thus Ekkehard merely joined in the popular refrain.

The Condition of the Empire in 1095

Finally, we may examine the best authorities as to the condition of the Empire. If, as Bernold says, the strait alone saved the capital, then Alexius may well have sought aid. Unfortunately, the words

[1] Details in *Hagenmeyer's* edition (Tübingen, 1877).

[2] Notably in chapters xiii and xxiv.

[3] See note 2, p. 138.

[4] "Predictus etiam Alexius . . . . non paucas epistolas Urbano papae direxit, quibus in defensionem orientalium ecclesiarum se non sufficere deploravit, obtestans totum, si fieri posset, Occidentem sibi in adiutorium advocari, promittens per se cuncta necessaria proeliaturis terra marique ministrari."

[5] The anti-Pope destroyed Urban's correspondence in August, 1098. *Archives de l'Orient latin*, I, p. 107.

[6] *Recueil* III: "Populus semper ei maledicat et proclamet eum proditorem." They also believed he abandoned the company of Peter the Hermit near Nicea.

which Bernold attributes to the embassy of 1095 recur in almost identical phraseology in Gregory's letter[1] of March 1, 1074, addressed *To All Christians.* But if we waive this objection as to form, we must insist that the contents also are at least misleading. Granting some exaggeration on the part of the envoys, we must nevertheless deny the circumstantial evidence supporting the alleged appeal. No crisis existed in or about 1095, to justify any appeal. When Alexius sought aid in 1082, 1084 and 1088 there were special reasons for his actions. A call for mercenaries about 1091 was merely incidental to the use of such troops.[2] Certain writers assert without adequate proof[3] that Alexius was planning the recovery of the provinces which were lost in 1071. If this be true, they are really denying the necessity, and consequently the probability, of an appeal in 1095.

The latest work devoted to the reign of Alexius declares plainly that in 1095 the empire was enjoying greater peace and tranquillity than it had known in fifteen years.[4] There are two reasons for this condition: the increasing control which the new ruler was exercising, and the dissensions of his enemy, the Turk. In 1081 Alexius was a usurper; by 1095 he had put down his rivals and ruled without dispute. Secondly, the Sultan Malek-Shah died in 1092 and the rival factions among the Turks quarreled savagely over his dominions.[5] So fierce were their wars that the Crusaders' success was almost inevitable, and the alliance with Egypt a logical result. So little was the great city in danger that the motley hosts of Peter the Hermit advanced perhaps a hundred miles beyond the strait before they met their fate.

[1] Jaffe, *Regesta*, 4826, and Migne, *P. L.*, CLXVIII. 329: " . . . . cognovimus gentem paganorum contra Christianum fortiter invaluisse imperium, et miseranda crudelitate jam fere usque ad muros Constantinopolitanae civitatis omnia devastasse et tyrannica violentia occupasse, et multa millia Christianorum quasi pecudes occidisse" (1074).

Bernold merely substitutes the churches for the empire—"ecclesiam, quam pagani jam pene in illis partibus deleverant, qui partes illas usque ad muros Constantinopolitanae civitatis obtinuerant, ..." (1095).

[2] *Essays on the Crusades* (1903) p. 92, the words of M. Diehl. Cf. also Freeman, *Norman Conquest* (1873), IV, 426–428.

[3] For example, Kugler in *Hist. Zeitschrift*, 1866, p. 304, note 16; a critical contention in his thesis, but no proof.

[4] Chalandon, *Essai* . . . . (1900), pp. 156, 158.

[5] Röhricht has an admirable résumé, with citations to the sources, in his *Geschichte des ersten Kreuz.*, 226–234.

Conclusion

It is therefore strangely significant that no eyewitness of the council, no contemporary chronicler, no Crusader who passed near Placentia on his way to the Orient, no Crusader who wrote home about the expedition, no contemporary Latin historian, no Greek contemporary, no official document either Latin or Greek, and no events within the empire itself furnish any definite corroboration of Bernold's story concerning an official appeal involving the two greatest potentates of Europe, delivered before an immense assembly, and distinctly regarded by modern historians as the immediate occasion of the First Crusade. Three eminent historians must be exempted from this charge. Friedrich von Raumer felt misgivings as to the alleged appeal because Anna Comnena did not mention it. He concealed his opinion in a footnote after giving the traditional tale.[1] Somewhat more boldly Count Riant challenged it, but confined his criticism to the omissions in Italian writers.[2] Very recently Röhricht confessed his inability to reconcile the program of Placentia with that of Clermont because Jerusalem does not appear in the former. He regrets that his sources do not afford an adequate explanation.[3] Thus have three eminent scholars presented their objections, each from a different standpoint. The present study arises out of a consideration of these and other suggestions, seeking indeed not a complete proof of the impossibility of an appeal in 1095, but a demonstration of the improbability of Bernold's story, in the light of all the evidence extant. Great events do not always have a dramatic inauguration: although our Civil War began with the firing on Fort Sumter, the Russo-Japanese war began when Japan was ready to spring and without previous announcement of hostilities. The Council of Clermont furnishes a sufficiently dramatic inauguration of the Crusade. Its basis is a long series of appeals—military, ecclesiastical and personal—and not the single incident recorded by a solitary writer.

[1] *Gesch. der Hohenstaufen und ihrer Zeit* (1857), p. 28 note 3.

[2] *Epistola Spuria* (1879), xxii, *et passim.*

[3] *Geschichte des ersten Kreuz.*, pp. 19, 20: " . . . . ihr Ziel war aber nicht mehr, wie noch in Piacenza, Constantinopel, sondern Jerusalem, ihre Gestalt nicht mehr die blosse Defensiv, sondern die Offensiv. Wodurch diese Verschiebung und Veränderung eigentlich veranlasst wurde, sagen die Quellen nicht. Vielleicht . . . . " u. s. w. The easiest escape from this dilemma is to ignore Bernold.

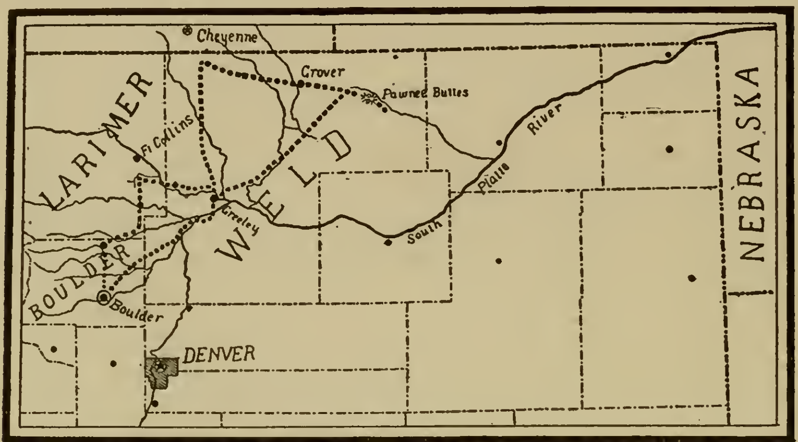
SCIENTIFIC EXPEDITION TO NORTHEASTERN COLORADO

I. GENERAL ACCOUNT WITH OBSERVATIONS ON TOPOGRAPHY AND METEOROLOGY

By GIDEON S. DODDS

During the summer of 1906 the University of Colorado sent out a scientific expedition to the northeastern part of the state, under the direction of Junius Henderson, curator of the museum. The expedition started from Boulder on June 7 and spent thirty days in the field. The party, consisting of four persons connected with the departments of Biology and Geology, traveled by wagon and visited parts of Boulder, Larimer and Weld Counties. The total distance covered was over 350 miles.

The purpose of the expedition was to cover considerable ground and to do work of a preliminary nature rather than to make exhaustive collections. In the field each man had his part of the work to do. In this way it was possible to collect a considerable variety of materials. Probably the most valuable part of the collections made are the fossil specimens from various localities. The plant collections are also important. During the trip a large number of small lakes were visited and a considerable collection of mollusks made. A small collection of bird and mammal skins was also made. In addition to these, miscellaneous specimens were obtained including insects, reptiles etc. Besides the actual collecting an important part of the work was the preparation of notes on such points as topography, stratigraphy, distribution of birds, etc. Also a considerable number of photographs were taken showing the character of the country and other points of interest.



Map Showing Route of the Expedition

On the above map the route of the expedition is indicated by the heavy broken line. Near Lyons about 15 miles north of Boulder plant collections were made and on the Little Thompson Creek a few miles farther on a small collection of fossils. On Fossil Creek, near Trilby siding, a few miles south of Fort Collins, the expedition made a halt of five days and collected considerable fossil and plant material, as well as some birds and mammals. From the exposures on the south side of the Cache la Poudre River near Windsor, an interesting collection of fossils was made. Near the Davis ranch, a few miles east of Grover, a few vertebrate remains were collected from the Tertiary exposures. The plant collections described in another part of this paper were made in this locality. Some valuable fossil material was obtained along Crow Creek, between this place and Greeley and also near the mouths of the Thompson and St. Vrain Creeks southwest of Greeley.

An important part of the work of the expedition was done in the northern part of Weld County, on the borders of the high plains, so a brief account of the topography and climatic conditions of this region may be of interest. Extending in an east and west direction, near the

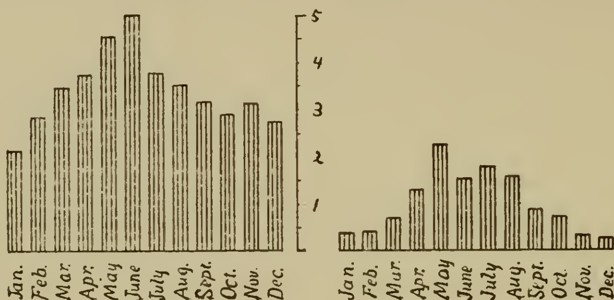
Wyoming and Nebraska line, is a series of bluffs facing southward. These are a very striking feature of the landscape,[1] rising in places as perpendicular cliffs to a height of perhaps 200 feet. Isolated remnants, parts of the cliffs separated by long continued erosion, remain standing in places as imposing towers rising high above the plains. Of these, Pawnee Buttes are striking examples. In these cliffs are exposed the clays and sand-stones of Tertiary age which are so rich in vertebrate remains. From the base of these cliffs the rolling plains slope gently away southward to the Platte River. From the top of the cliffs, the high plains[2] extend away to the northward.

The Tertiary formations bordering the high plains were visited first at Chalk Bluffs,[3] near Cheyenne. Though fossil remains are very plenty in these formations at other places, the expedition was unable to find any in this locality. Around the Davis ranch, a few miles east of Grover, these formations are very rich in vertebrate remains. Here an expedition from the American Museum of Natural History about seven years ago camped for a considerable time and collected much valuable material. Our expedition spent only six days in this region, making collections noted in the following article. A knowledge of the country and of conditions here, and about Pawnee Buttes a few miles farther east, was gained. This knowledge will be of value in future work.

The climate of the region is an arid one. The amount of rainfall at Pawnee Buttes can only be approximated by comparing records from the nearest stations which are about 50 miles away. At Cheyenne, Wyoming, the mean annual rainfall is 12.20 inches. At Greeley it is 11.16 inches. In the Pawnee Buttes region it is probably somewhat greater, possibly 13 inches. This is less than at most places on the eastern plains of the state. The streams in this region are intermittent, most of them carrying only storm water. In most localities wells of moderate depth give a fair supply of good water. The meager rainfall supports a growth of grass sufficient to pasture a considerable number of cattle and sheep. Besides grasses the plants are chiefly early-flowering perennial herbs with some late-blooming composites such as species of Artemisia. This growth of vegetation would not be possible with so

[1] See Fig. 1, Plate I. [2] See Fig. 2, Plate I. [3] See Fig. 1, Plate II

little precipitation but for the fact that by far the greater part of the year's rain falls during the spring and early summer. Were it distributed more evenly throughout the year, there would not be enough during the growing season to support even this small amount of vegetation. This unequal distribution of rainfall is characteristic of arid climates. In more humid climates there is a more general distribution throughout the year. A comparison of these two conditions is shown in the accompanying diagrams. Cheyenne with a rainfall of 12.20 inches is taken as a type of the arid region and St. Louis with 40 inches is used as a type of the more humid. The rainfall for the different months is shown in inches. The temperature of this region presents no local features of



Monthly Distribution of Rainfall at St. Louis, Mo., and Cheyenne, Wyo.
(See Explanation in Text)

interest. The winters are cold, the summers hot. The extremes between day and night are considerable, as is common in arid climates.

The work of this expedition is but the beginning of what the University hopes in time to be able to do. Here in Colorado the naturalist has before him a very exceptional field. In a large part of the state little scientific work has been done. The wide diversity of climatic conditions occurring within the state, from mountain to plain, support a flora and fauna of corresponding variety. There are already known in Colorado over 2,900 species of seed-plants and ferns, a number exceeded by no other state in the union but California and possibly Florida.[1] We have here a field for research and exploration in which very little has been done. In working this field we need have no fear of duplicating

[1] Rydberg, *Flora of Colorado*, p. xv, 1906.

work of earlier students. The careful student may expect to discover much that is new to science. In gaining knowledge of his own state he is extending the knowledge of the world.

So far the University of Colorado has put forth but little effort along this line. This little effort, however, has been fruitful in results and promises great things for the future. We need expect nothing spectacular, but we may reasonably expect systematic and persistent effort to be many times repaid. The results accomplished by the expedition to which this account is devoted are simply an illustration of what may be done with a very small expenditure of time and money. The several accounts to follow give a fuller description of a part of the work done. The notes and material of the expedition will be useful in the preparation of more detailed papers to be issued later.

2. Paleontology—Account of Collections Made

By Junius Henderson

The first paleontological work was done just outside the mouth of Little Thompson canyon, northeast of Lyons, in Boulder County. There a *cache* made several years ago was visited and the hidden collection carried away. The collection consisted of some large fossil bivalves (*Inoceramus deformis*) somewhat like clams of the present day. The shells showed a well-marked constriction isolating the umbones from the later accretions of the shell. This peculiarity gives the shell the appearance of having completed its growth and then, as an afterthought, having built a less strongly undulating extension. This same condition sometimes occurs with *I. oblongus* at Fossil Ridge and with *I. sagensis* three miles north of Boulder. It affords a striking example of variation along parallel lines.

Further east in the same valley, below the Hygiene sandstone in the lower third of the Pierre group, a limestone concretion was found containing numerous fossils. Prominent among these were a large number of cephalopod fossils (*Baculites compressus*). There were also other well-known Pierre fossils, including one undetermined bryozoan. So far as known to the writer this is the only one, with a single exception, thus far collected in this region.

The next camp for paleontological purposes was about seven miles south of Ft. Collins at Trilby Schoolhouse. At this point work was done on Fossil Ridge, which extends north and south parallel with the Colorado & Southern Railway. The ridge consists of a soft sandstone in which are numerous concretions which contain fossils. This place is the type locality for several species and abounds in individuals of other species, particularly the large bivalve, *Inoceramus oblongus*. It is not uncommon to find a dozen or more of these shells six to eight inches in length, in a single concretion two or three feet in diameter. An extensive collection was obtained here. Some of the species obtained had not been previously reported from Colorado. Excellent series of several species were collected showing extremes of variation. Some of these series will be useful for students as illustrating features of interest from the standpoint of evolution. With these collections the University museum now has more than twice as many species as have been recorded for Fossil Ridge.

Fossil Ridge is one of the most important localities in Colorado for invertebrate fossils, yet it has received very meager treatment in the literature of paleontology. With the material now in hand and with a little more field-work to determine some questions of stratigraphy, it will be possible to prepare a valuable report treating the locality with the detail which it deserves.

Along the bluffs of the Cache la Poudre River a short distance southeast of Windsor several hundred specimens of a fossil bivalve, *Veniella humilis*, were collected in an excellent state of preservation. Besides these, there were two almost perfect specimens of another mollusk, *Pholodomya subventricosa*. These were from beds which may be assigned either to upper Pierre or to lower Fox Hills. Above, in undoubted Fox Hills strata, were found a number of species in much better condition than is usual in the friable sandstone of that group.

West of Pawnee Buttes, in eastern Weld County, a general survey of the field was made. Previous expeditions to this region had picked up the most available material so that no extensive collections were obtained. All fossils here are of vertebrate animals. A collection was made consisting of a number of fossil jaw bones of various land forms.

A large land tortoise, chiseled from the sandstone, was the most important specimen secured. This was taken from a point about eight miles west of the Buttes.

The next work was done in the Laramie group on the east side of Crow Creek about twenty miles northeast of Greeley. Here, naturally, the fossils are of invertebrates. This place, like Fossil Ridge, is the type locality for a number of species, but the fauna is characteristic of fresh and brackish water lagoons. The shells are found in thick layers, many of them in a very fine state of preservation. There is little alteration of the material composing the shells, they weather freely from their matrix, and the species show a resemblance to those of later faunas. Hence these beds have a decidedly Tertiary aspect, but of their Laramie age there is no room for doubt.

On the return trip collections were also made at the mouth of the Thompson and near the confluence of the St. Vrain and the South Platte. At the former station a fossil leaf was found in the Fox Hills sandstone of Cretaceous age. This has been determined by Professor T. D. A. Cockerell as a species of *Ficus*, a genus of trees to which the cultivated fig belongs. Near the mouth of the St. Vrain a large number of fossil shells were obtained. Especially worthy of record is a fine series of oysters,[1] which weathered out from the soft matrix in perfect condition of preservation.

From the foregoing account it will be seen that of all the points visited Pawnee Buttes alone furnishes vertebrate fossils. The other localities are rich in invertebrate material, especially the bivalves, gastropods, and cephalopods. At Fossil Ridge the fullest collections were made. Another expedition should make collections and do stratigraphic work there, in order that this one locality may be thoroughly understood and the results published.

The Fossil Ridge material has not yet been fully examined, but there are at least the following species as the result of the expedition:

Halymenites major Lx.
Chaetetes dimissus White
Membranipora sp.
Serpula sp.
Anatina sp.
Anomia raetiformis Meek

[1] *Ostrea glabra.*

Callista deweyi M. & H.
Cardium speciosum M. & H.
Glycimeris berthoudi White
Inoceramus oblongus Meek
Inoceramus vanuxemi M. & H.
Inoceramus sagensis Owen
Inoceramus barabini Morton
Ostrea patina M. & H.
Ostrea pellucida M. & H.
Pinna lakesi White
Pteria linguiformis E. & S.
Pteria nebrascana E. & S.
Thracia gracilis M. & H.
Volsella meekii E. & S.
Anchura americana E. & S.
Anchura haydeni White
Anisomyon borealis Morton
Anisomyon centrale Meek
Anisomyon patelliformis M. &. H.
Capulus sp.
Gyrodes sp.
Margarita nebrascensis M. & H.
Baculites compressus Say
Baculites ovatus Say
Placenticeras whitfieldi Hyatt
Placenticeras intercalare M. & H.
Scaphites nodosus Owen

The Crow Creek fossils collected have been fully studied except a good-sized box of *Corbicula*, which may afford some species not yet identified. With this exception the species found are as follows:

Anomia micronema Meek
Corbicula berthoudi White
Corbicula cardiniaeformis White
Corbicula cleburni White
Corbicula fracta Meek
Corbicula macropistha White
Corbicula obesa White
Corbula subtrigonalis M. & H.
Ostrea glabra M. & H.
Bulinus disjunctus White
Campeloma multilineata M. & H.
Goniobasis gracilenta Meek
Goniobasis tenuicarinata M. & H.
Melania wyomingensis Meek
Physa sp.
Tulotoma thompsoni White

3. A New Plant (Ficus) from the Fox Hills Cretaceous

By T. D. A. Cockerell

Among the valuable materials brought home by the expedition is a large fossil leaf, with portions of others, from the Fox Hills Cretaceous. This was found by Judge Henderson near the mouth of Thompson Creek, west of Evans, in the upper part of the beds there exposed. There is no doubt about the age of the rock containing the vegetable remains, as *Cardium speciosum*, a characteristic Fox Hills shell, was found above it. The specimen is of peculiar interest, as no seed-plant has hitherto been described from these beds in Colorado.

Ficus sp. nov.

Represented by the upper portion of a leaf lacking the apex, and the side of the lower portion of another. Leaf large, 12 cm. in diameter, probably about 24 cm. long, apparently very thick, with pinnate venation, and the margin nearly entire, but faintly undulate, with slightly indicated and remote teeth near the middle. Lateral veins (secondary) few, alternate, those of either side about 22 mm. apart, leaving the midrib at an angle of about 45°, slightly curved, strongly curved upward toward their ends where they become parallel with the midrib, finally branching, and failing to reach the margin; toward the apex the lateral veins become closer, and in one place two arise nearly together; cross-veins (nervilles), between the laterals, numerous, the principal ones about thirteen in number between two laterals near the middle of the leaf, these cross-veins often bent near the middle, and in general directed somewhat obliquely, neither at right angles to the midrib, nor to the laterals; region between the cross-veins broken into many small mostly quadrangular areas by crossing veinules. The side of the base of another leaf shows the main laterals closer together, the fourth only about 21 mm. from the first (and doubtless nearer at point of origin), and the first only about 6 mm. from the margin, the usual curved veins leaving its lower side at intervals of about 8 mm.

Among living species of *Ficus*, this may be compared with *F. sycomorus* L., but that has no closely adjacent basal laterals. The basal region of our leaf is much more like that of *Artocarpoides conocephaloides*[1] Saporta, but the cross-veins are not so numerous, or quite so oblique, as in that leaf. There is quite a close resemblance to, and very likely real relationship with, *Pterospermites undulatus* Knowlton, but that differs in the structure of the basal parts, is apparently a narrower leaf, and the region between the nervilles is very much less divided into spaces. None of the species of *Ficus* figured by Knowlton from the Montana formation agree at all closely. I had wished to name the plant after its discoverer, but owing to the imperfection of the material, it appears best to withhold a specific name. In doing this, I follow the advice of Dr. Arthur Hollick, who kindly examined a photograph of the specimen.

4. Birds—Account of Species Seen, with Distribution

By Harvey Markman

Traveling from the base of the foothills at Boulder to a point nearly a hundred miles out on the plains a territory was crossed in which the

[1] *Flora fossile de Sezanne*, Pl. VI.

representatives of certain western species gradually become fewer, and finally disappear, while some eastern forms, seldom seen near the mountains, become quite common. The northern violet-green swallow, although quite common in the foothill canyons, was seen only within a few miles of Boulder. Its near relatives, the cliff and barn swallows, with a much broader range, were seen almost everywhere on the trip. The cliff swallow was particularly noticeable. In the Chalk Bluffs region many clusters of the mud nests of this species were found.[1]

A bird seldom seen on the plains, but more or less common in the foothills, is the canyon wren. This species was observed only at a point four miles west of Trilby, where the spurred towhee was also seen for the last time. Two other wrens were frequently met with, the western house wren in the fringing forests of the St. Vrain and the Little Thompson and the rock wren which extends even to the more barren regions farther east and north. A rock wren's nest, carefully excavated, showed an excellent arrangement for concealing the young birds. The tunnel had the form of a capital Y, the nest, constructed of fine plant fibers, being located at the forking point. The floor of this tunnel and especially of the two branches, was lined with a layer of fine fibers resembling chopped tow. Two of the young fluttered from the nest, when it appeared wholly deserted. A careful examination was now made of the two side passages. Here no less than five young birds were carefully hidden away in the fibrous lining of the nest, which they resembled closely in color and general appearance.

Of the eastern birds that became abundant a distance out from the foothills the crow was perhaps the most conspicuous. This bird was seen along the rivers near New Windsor and also farther east, but was not observed on the high plains. On the other hand, the mocking bird was seen in the Pawnee Buttes region as well as along streams.

Most of the brilliantly colored birds, such as the Bullock oriole, evening grosbeak, lazuli bunting, yellow-throat and chat, were not seen away from the well-watered and timbered country. In drier places, as on the high plains, these species are replaced by birds having a dull

[1] See Fig. 1, Plate II.

plumage such as Brewer's sparrow, the mountain plover, meadowlark, lark bunting, burrowing owl, and the mocking bird.

The vicinity of Davis' ranch, eight miles west of Pawnee Buttes, was a favorite breeding-place for several species. Many recently deserted nests of Brewer's blackbird were found. Nests of the brown thrasher, mourning dove, white-rumped shrike and Say phoebe were not uncommon among the rocks and evergreens of the gullies. The most common nests were those of the Arkansas kingbird. Practically every cluster of pines had at least a pair of these noisy birds. Nests of Swainson's hawk were found both in trees and among the rocks, one with eggs, one with newly hatched young and others with young well advanced in growth.

On the homeward journey by far the most interesting thing in the way of bird life was a heronry on Crow Creek, where a colony of great blue herons had established themselves in a long narrow grove of cottonwoods which followed closely the winding of the stream bed. High up among the smaller limbs of the tallest trees were perched the large dirty nests, sometimes half a dozen of them in a single tree.[1]

Since the collection of birds was not the primary object of the expedition, the list of those collected or identified is by no means complete. Many of the birds were in the midst of their breeding season, and on this account it was thought best not to do much collecting. Only such specimens were taken as would be new to the University collections. The following list contains the names of the birds collected together with those identified in the field. In most instances they are recorded from the nearest camping-place. With the more common species no attempt is made to give all the localities.

Great Blue Heron. *Ardea herodias.*
Windsor; Crow Creek.

Black-crowned Night Heron. *Nycticorax nycticorax naevius.*
Windsor.

Sora. *Porzana carolina.*

American Coot. *Fulica americana.*
Common on the lakes.

[1] See Fig. 2, Plate II.

WILSON PHALAROPE. *Steganopus tricolor.*
Windsor.

AMERICAN AVOCET. *Recurvirostra americana.*
Windsor.

SPOTTED SANDPIPER. *Actitis macularia.*
Big Thompson.

KILLDEER. *Oxyechus vocifera.*
Boulder; St. Vrain; Windsor.

MOUNTAIN PLOVER. *Podasocys montana.*
Fossil Ridge; Eastman's Reservoir.

MOURNING DOVE. *Zenaidura macroura.*
Boulder; St. Vrain; Grover.

TURKEY VULTURE. *Cathartes aura.*
St. Vrain; Davis' Ranch.

SWAINSON HAWK. *Buteo swainsoni.*
Davis' Ranch; Pawnee Buttes; Crow Creek.

FERRUGINOUS ROUGHLEG. *Archibuteo ferrugineous.*
Crow Creek.

SPARROWHAWK. *Falco sparverius.*
St. Vrain.

BURROWING OWL. *Speotyto cunicularia hypogaea.*
Trilby; Grover.

BELTED KINGFISHER. *Ceryle alcyon.*
St. Vrain.

RED-HEADED WOODPECKER. *Melanerpes erythrocephalus.*
St. Vrain.

FLICKER. *Colaptes auratus luteus*
Identified by young birds found in a nest on Big Thompson.

RED-SHAFTED FLICKER. *Colaptes cafer collaris.*
St. Vrain.

WESTERN NIGHTHAWK. *Chordeiles virginianus henryi.*
Fossil Ridge.

WHITE-THROATED SWIFT. *Aëronautes melanoleucus.*
Davis' Ranch.

KINGBIRD. *Tyrannus tyrannus.*
Boulder; St. Vrain; Crow Creek.

ARKANSAS KINGBIRD. *Tyrannus verticalis.*
Davis' Ranch; Crow Creek.

SAY PHOEBE. *Sayornis saya.*
Chalk Bluffs; Davis' Ranch.

WESTERN WOOD PEWEE. *Contopus richardsonii.*
St. Vrain.

Desert Horned Lark. *Otocoris alpestris leucolæma.*
Eastman's Reservoir; Grover.
Black-billed Magpie. *Pica pica hudsonia.*
Little Thompson; Crow Creek.
American Crow. *Corvus brachyrhynchos.*
Cache la Poudre.
Cowbird. *Molothus ater.*
Big Thompson.
Yellow-headed Blackbird. *Xanthocephalus xanthocephalus.*
West of Windsor.
Redwinged Blackbird. *Ægelaius phœniceus.*
Boulder; St. Vrain; Little Thompson.
Western Meadowlark. *Sturnella magna neglecta.*
Boulder; St. Vrain; Little Thompson; Grover; Crow Creek.
Bullock Oriole. *Icterus bullocki.*
Little Thompson; Crow Creek.
Brewer Blackbird. *Euphagus cyanocephalus.*
Davis' Ranch; Crow Creek.
Western Evening Grosbeak. *Hesperiphona vespertinus montanus.*
St. Vrain.
House Finch. *Carpodacus mexicanus frontalis.*
St. Vrain; Big Thompson.
English Sparrow. *Passer domesticus.*
Boulder; Loveland, etc.
Western Vesper Sparrow. *Poœcetes gramineus confinis.*
St. Vrain.
Western Lark Sparrow. *Chondestes grammacus strigatus.*
St. Vrain.
White-crowned Sparrow. *Zonotrichia leucophrys.*
St. Vrain.
Brewer Sparrow. *Spizella breweri.*
Slayton's Ranch.
Spurred Towhee. *Pipilo maculatus megalonyx.*
St. Vrain; Foothills west of Trilby.
Lazuli Bunting. *Cyanospiza amœna.*
St. Vrain.
Lark Bunting. *Calamospiza melanocorys.*
St. Vrain.
Cliff Swallow. *Petrochelidon lunifrons.*
Boulder; Trilby; Chalk Bluffs, Grover.
Barn Swallow. *Hirundo erythrogastra.*
Boulder; Trilby; Grover.

NORTHERN VIOLET-GREEN SWALLOW. *Tachycineta thalassina lepida.*
Boulder.
WHITE-RUMPED SHRIKE. *Lanius ludovicianus excubitorides.*
Davis' Ranch; Crow Creek.
YELLOW WARBLER. *Dendroica æstiva.*
St. Vrain; Little Thompson; Windsor.
WESTERN YELLOW-THROAT. *Geothlypis trichas occidentalis.*
St. Vrain.
LONG-TAILED CHAT. *Icteria virens longicauda.*
St. Vrain.
WESTERN MOCKING BIRD. *Mimus polyglottos.*
Davis' Ranch; Crow Creek.
CATBIRD. *Galeoscoptes carolinensis.*
St. Vrain.
BROWN THRASHER. *Toxostoma rufum.*
St. Vrain; Davis' Ranch.
ROCK WREN. *Salpinctes obsoletus.*
Boulder; Chalk Cliffs; Eastman's Reservoir; Davis' Ranch.
CANYON WREN. *Catherpes mexicanus conspersus.*
Foothills west of Trilby.
WESTERN HOUSE WREN. *Troglodytes aëdon aztecus.*
St. Vrain; Little Thompson.
WESTERN ROBIN. *Merula migratoria propinqua.*
Boulder; St. Vrain.

5. LIST OF MOLLUSKS COLLECTED

BY JUNIUS HENDERSON

The following recent Mollusca were collected by the expedition. The *Sphærium* is a new species.

Strophitus edentulus pavonius Lea
Sphærium hendersoni Sterki
Pisidium compressum Prime
Oreohelix strigosa Gould
Oreohelix strigosa albofasciata Hemphill
Pupilla blandi Morse
Zonitoides arboreus Say
Vallonia cyclophorella Ancey
Lymnæa caperata Say
Lymnæa obrussa Say
Lymnæa palustris Müll.

Planorbis bicarinatus Say
Planorbis parvus Say
Planorbis trivolvis Say
Physa gyrina Say
Ancylus caurinus Cooper

Results of this collection are recorded in the articles on "The Mollusca of Colorado" which are published in this and the preceding number of these *Studies*.

6. List of Mammals Collected or Noted

By Harvey Markman

The following list includes the mammals collected or carefully noted on the trip. It was found difficult to obtain collections partly owing to the scarcity of mammals and partly because of lack of time. Besides the following a small rodent was collected at Trilby which seems to be a vole, but the specimen was partly eaten while still in the trap and identification is difficult.

White-footed mouse. St. Vrain.
Yellow pocket gopher. Common at Loveland.
Cottontail. Trilby; Davis' Ranch.
Coyote. Fossil Creek.
Skunk. Fossil Creek.
Badger. Fossil Creek.
Prairie dog. Trilby; Grover, etc.
White-tailed jack rabbit. Trilby.
Thirteen-striped gopher. Trilby; Grover, etc.
Packrat. Davis' Ranch.

7. Note on the Butterflies of the Genus Neominois

By T. D. A. Cockerell

The genus *Neominois* (family Satyridæ) is credited in our lists with two species, *N. ridingsii* Edwards, 1865, and *N. dionysius* Scudder, 1878. Several specimens were obtained by the University of Colorado expedition of 1906 ten miles east of Grover, in Weld Co., Colorado, June 29. I had assumed that these were the common *N. ridingsii*, but Mr. S. A. Rohwer pointed out to me that they showed certain resemblances to *N. dionysius*—in their cinereous color, with the basal area of the wing often pale and contrasting, and the serrations of the outer edge of the band on the hind wing strongly marked. The size is not too great for *N. ridingsii.* A closer study of the material confirms the original reference to *N. ridingsii*, but at the same time suggests that further collections of *Neominois* will yield facts of great interest from an evolutional standpoint.

The true *Neominois ridingsii* is an insect of the front range in Colorado, ascending to .9000 ft. at Gem Lake, Estes Park (Gillette). It is common in open grassy places at 8,000 ft. It descends, however, to the plains at the base of the mountains, near Denver (Mead) and elsewhere. It goes northward as far as Manitoba.

Neominois dionysius occupies the Great Basin, and was described from the Juniper Mountains, Arizona, and Mount Trumbull, Utah, places not very far apart. It is a larger, gayer, insect, with the ocelli on the front wings very large, and the serrations of the band of the hind wings very marked. The male expands 48–51 mm., the female 55–58½. As might be expected, it occurs also in western Colorado, where it has been obtained by Bruce. On the other side of the Great Basin, in Nevada, there is found a butterfly which Edwards distinguished in 1870 by the name *stretchii*, but which is now placed in all catalogues as a synonym of *N. ridingsii.* This insect is larger than the Colorado form, but has in general the characters of *ridingsii*, not of *dionysius.*

Finally, we have a record[1] of *N. dionysius* from the eastern plains, in Sioux Co., Nebraska.

In all this we appear to have a very clear and interesting case of response to climatic conditions, and probably of the independent development of similar types under similar environments. Mead remarks that the color of the butterflies, as seen near Denver, harmonizes excellently with that of the dry herbage among which they rest, and renders them difficult of detection. It would be of great interest to secure full series from different altitudes and regions, with particulars concerning their surroundings, and see whether several minor races could not be distinguished. It seems probable that the Nebraska "*dionysius*" is derived from *ridingsii*, not from the genuine *dionysius* of the Great

[1] *Cf.* Skinner, *Syn. Cat. N. A. Rhopalocera*, Suppl. No. 1, p. 114.

Basin, and represents a further development of the tendencies already evident in the material obtained by Judge Henderson's expedition. The following scheme will indicate the general facts, as I understand them:

Sierra Nevada	Great Basin	Rocky Mountains	Plains East of Rocky Mts.
N. stretchii = topomorph of *ridingsii*	*N. dionysius*	*N. ridingsii*	*N.* derivative of *ridingsii* simulating *dionysius*

8. Botany—Account of Collections Made

By Francis Ramaley

No attempt was made to secure complete collections at the places visited since members of the party were chiefly engaged in other work. Some herbarium specimens were collected, representing the more common plants of typical localities. Notes were taken regarding the distribution of plants on mesas and in gulches. A general survey was made to determine the places where further study should be undertaken.

Collections were made as follows: (*a*) In a cottonwood forest along the St. Vrain Creek about a mile below Lyons, Boulder County—75 numbers; (*b*) Fossil Creek, seven miles south of Ft. Collins, Larimer County—plants of the ridge, 60 numbers, valley plants 51 numbers, roadside plants—35 numbers; (*c*) High plains and the bluffs bordering these about eight miles west of Pawnee Buttes in Weld County—67 numbers; total 288 numbers. So far as possible the plants were collected in duplicate and specimens sent to Professor Aven Nelson for identification. In a few cases material was not in condition and could not be identified with certainty. Most of it was satisfactory, and with even the few specimens collected, a fair idea of the floral characters of the country can be obtained.

In general the plants are those characteristic of the eastern plains region of the state. The climatic conditions are distinctly xerophytic, hence dry-country plants[1] are the rule except in river bottoms. Plants of the pulse family are especially conspicuous in most of the dry locali-

[1] See Fig. 2, Plate I.

ties. Particular mention may be made of the loco weeds[1] which occur on plains and bluffs. Another plant of this family, a species of *Psoralea*,[2] is the dominant plant on the mesas and ridges and much of the plains formation in early summer. It has somewhat the appearance of sweet clover or alfalfa but grayish in color and with few leaves. Along with the *Psoralea* are found one or more shrubby species of wormwood.[3]

Well-developed river-bottom forests[4] occur along the St. Vrain Creek below Lyons and especially along the Poudre River near Windsor there is some fringe of forest[5] accompanying all of the water courses. At the first point named above the trees are chiefly narrow-leaf cottonwoods with some western cottonwoods.[6] Other trees are small birches,[7] alders[8] and box-elders.[9] The Poudre forest is made up of the common western cottonwood together with box-elders and two or three willows. Here there is often a dense undergrowth of rank herbs and such trailing and creeping plants as hops, clematis and Virginia creeper[10] and poison ivy.[11]

The total number of trees and shrubs in the region studied is small. Besides those species which occur in river bottoms there are certain trees which grow only on the bluffs and near the heads of gulches. An especially interesting place is the bluff at the southern limit of the high plains about eight miles west of Pawnee Buttes. Here the western cedar[12] was found and also one of the five-leaved pines.[13] The occurrence of the latter is particularly noteworthy as this tree has not been reported in Colorado except from high mountain stations. The shrubs growing along these bluffs are the skunk bush[14] and the mountain mahogany.[15] Following is a list of all the woody plants collected by members of the party.

[1] Species of *Astragalus* and *Aragallus*.

[2] *Psoralea tenuiflora* Pursh.

[3] *Artemisia*.

[4] See Fig. 3, Plate I.

[5] See Plate II.

[6] *Populus sargentii* Dode=*P. occidentalis* (Rydb.) Britt.

[7] *Betula fontinalis* Sarg.

[8] *Alnus tenuifolia* Nutt.

[9] *Acer negundo* Linn.

[10] *Parthenocissus vitacea* Hitch.

[11] *Rhus rydbergii* Small.

[12] *Juniperus scopulorum* Sargent.

[13] Probably *Pinus flexilis*.

[14] *Rhus trilobata*.

[15] *Cercocarpus parvifolius*.

Woody plants of river bottoms and moist gulches:
- *Salix amygdaloides* Anders.
- *Salix exigua* Nutt.
- *Populus angustifolia* James
- *Populus sargentii* Dode = *P. occidentalis* (Rydb.) Britt.
- *Alnus tenuifolia* Nutt.
- *Betula fontinalis* Sarg.
- *Clematis ligusticifolia* Nutt.
- *Ribes vallicola* Greene
- *Rhus rydbergii* Small
- *Acer negundo* Linn.
- *Parthenocissus vitacea* Hitch.
- *Vitis vulpina* Linn.

Woody plants of dry hills and bluffs:
- *Pinus flexilis* James ? (collected without cones)
- *Juniperus scopulorum* Sarg.
- *Ribes cereum* Dougl.
- *Cercocarpus parvifolius* Nutt.
- *Rhus trilobata* Nutt.

The collection of plants made at Pawnee Buttes is of interest because it represents the flora of the driest part of the high plains. Nothing seems to have been published thus far concerning the plants of the district. On this account a list of the specimens collected is given in full, so far as determinations have been made.

List of plants collected about eight miles west of Pawnee Buttes:[1]
- *Pinus flexilis* James
- *Juniperus scopulorum* Sarg.
- *Tradescantia scopulorum* Rose
- *Agropyron* sp.
- *Bulbilis dactyloides* (Nutt.) Raf.
- *Eriocoma cuspidata* Nutt.
- *Kœleria cristata* (Linn.) Pers.
- *Stipa spartea* Trin.
- *Zygadenus falcatus* Rydb.
- *Eriogonum alatum* Torr.
- *Eriogonum effusum* Nutt.
- *Atriplex* sp.
- *Eurotia lanata* (Pursh) Moq.

[1] Determinations in most cases were made by Professor Aven Nelson of the University of Wyoming.

Abronia micrantha A. Gray
Paronychia pulvinata A. Gray
Delphinium geyeri Greene
Lesquerella montana (A. Gray) S. Wats.
Ribes cereum Dougl.
Cercocarpus parvifolius Nutt.
Astragalus adsurgens Hook.
Astragalus microlobus A. Gray
Astragalus pectinatus A. Gray
Astragalus multiflorus A. Gray
Petalostemon sp.
Psoralea tenuiflora Pursh.
Linum aristatum Engelm.
Linum puberlum (Engelm.) Heller
Euphorbia fendleri (T. & G.) Small
Euphorbia robusta (Engelm.) Small
Rhus trilobata Nutt.
Malvastrum dissectum (Nutt.) A. Nels.
Opuntia polyacantha Haw
Opuntia rhodantha K. Sch.
Echinocereus viridiflorus Engelm.
Gaura coccinea Nutt.
Gaurella guttulata (Geyer) Small
Galpinsia lavandulæfolia (T. & G.) Small
Meriolix serrulata (Nutt.) Walp.
Gilia iberidifolia Benth.
Phlox andicola (Britt.) E. Nels.
Allocarya scopulorum Greene
Oreocarya suffruticosa (Torr.) Greene
Phyla cuneifolia (Torr.) Greene
Pentstemon albidus Nutt.
Thalesia fasciculata (Nutt.) Britt.
Artemisia aromatica E. Nels.
Erigeron pumilus Nutt.
Hymenopappus cinereus Rydb.
Lygodesmia juncea (Pursh) D. Don
Thelesperma intermedium Rydb.
Townsendia grandiflora Nutt.

In the above list it will be seen that no species new to science were obtained. However, the known range of some of the species was con-

Fig. 1

Fig. 2

Fig. 3

Scientific Expedition to Northeastern Colorado

Plate I


Fig. 1


Fig. 2

Scientific Expedition to Northeastern Colorado
Plate II

siderably extended by these collections. From the specimens at hand a general idea of the flora can be obtained and further collections can be intelligently undertaken. As the specimens were all gathered about the last of June it is desirable that future and more complete collections be made later in the season.

EXPLANATION OF PLATES

PLATE I

FIG. 1.—Bluffs at southern edge of high plains east of Grover, Weld Co., Colo. These bluffs consist of sandstones and clays belonging to the Loup Fork and White River beds. They contain numerous vertebrate remains. The illustration shows how portions of the bluffs may be cut off as isolated buttes. The region in the foreground belongs to the eroded area of the South Platte River valley.

FIG. 2.—View on the high plains to the north of the bluffs shown above. Note the very flat character of the country with its sparse vegetation of coarse composites and bunch grass.

FIG. 3.—River-bottom forest on the bank of the Cache la Poudre River near Windsor, Colo. The forest varies from fifty to a few hundred feet in width. The trees are chiefly cottonwoods and willows.

PLATE II

FIG. 1.—Nesting-site of cliff swallows at Chalk Bluffs in Weld Co., Colo., near Cheyenne, Wyo. In these bluffs no fossils were found by the expedition.

FIG. 2.—Cottonwood trees on Crow Creek with herons' nests in the upper branches. Note the stunted character of the trees. Along many of the creeks there are just such narrow lines of trees forming no true river-bottom forests.

THE MOLLUSCA OF COLORADO. PART II[1]

By Junius Henderson

Genus OREOHELIX Pilsbry

Oreohelix strigosa Gld. Fig. 3.

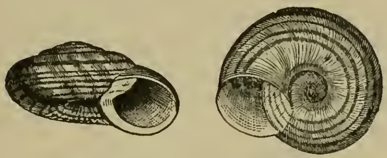


Fig. 3.—Oreohelix strigosa.

Patula strigosa. Grand River, Binney **5**, 623. Blue River and Saguache, Yarrow **68**, 930. North Park (E. A. Barber), Boulder and Magnolia (Henderson), Black Lake Creek (Cockerell), Larimer County (S. M. Edwards), Vanatta Mss.

Patula strigosa hemphilli Newc. Williams Canyon, Binney **6**, 168. See Cockerell **14**, 102; Sampson **46**, 102; Stearns **52**, 62.

Form *globosula* Ckll. (Described from one immature specimen) Black Lake Creek, Cockerell **14**, 101; Binney **7**, 170.

The confusion in the literature of this genus makes it impossible to be certain about the records of the various subspecies, and the large number of named forms of less than specific or subspecific value, some of which, at least, have been described from single specimens, has not assisted in bringing order out of chaos. The differences in color, number and width of bands, elevation of spire and deflection of last whorl toward the aperture are so marked even in specimens found together, and various forms which appear quite distinct when viewed separately pass into each other by gradation so insensible when considered in large series, that their separation becomes more a matter of opinion than of fact. Even such extreme forms as *hemphilli* are found in large series of specimens to pass into typical *strigosa* in such a way that no line can be drawn between them.[2] It is difficult to say whether some of the forms should be considered forms of *strigosa* or *cooperi*, or whether they should be designated as varieties, subspecies, mutants or forms. It was once said that *cooperi* was the common form in Colorado but the majority of specimens from east of the Front Range are now referred to *strigosa* and its varieties, while we have seen no living *cooperi*. The majority of specimens examined by the writer have two rather wide spiral bands, a few have one or two fine additional lines and a very few immature specimens have quite a number of obscure lines on the base. The species is common in the foothills and mountains from Boulder to Lyons and southward. We have found it fossil at Bear Canyon. Our finest specimens were collected

[1] Part I of this paper was published in Vol. IV of these Studies, pages 77 to 96 inclusive, and included an introduction, bibliography, locality list, key to species and an annotated catalogue of the *Pelecypoda*. In the citations of former records herein the figures in bold-faced type refer to the numbers of the publications listed in the bibliography in Part I, and the figures in light-faced type refer to the pages. The illustrations in this part are all electrotyped from originals used in the publications of Smithsonian Institution, by courtesy of the authorities of that institution. The introductory remarks in Part I included a list of the species added to the recorded fauna by this paper. Since it was published records of four more species have been added, namely: *Bifidaria pilsbryana* St., *B, hordeacella* Pils., *B. procera* Gld., and *Lymnaea leai* Baker, besides the hothouse specimen of *Vitrea alliaria* Drap.

[2] Pilsbry, *Man. Conch.*, *VIII*, p. 115; Stearns **50**, 96, **51**, 745, 746.

by Mr. A. Mackenzie on Mt. Audubon, altitude 11,000 feet, others were collected at Can yon City by Miss Voight, and dead specimens near Glenwood springs by Messrs. Horace. G. Smith and Will Huestis.

Oreohelix strigosa albofasciata Hemp.

A few specimens referred to this form were collected near Glenwood Springs by Mr. H. G. Smith, and at Lyons by the writer. In both instances they were associated with typical *strigosa.*

Oreohelix strigosa depressa Ckll.

Durango, Cockerell **12**, 8; **14**, 102; **23**, 107. Foothills near Boulder (Ralph V. Mann), Vanatta Mss. Described and recorded by Prof. Cockerell as a form of *cooperi,* but now considered a variety of *strigosa.*

Mr. S. R. Rohwer has collected a specimen at Boulder with the spire nearly flat.

Oreohelix strigosa concentrata Dall.

Colorado, Dall **33**, 1; **34**, 336. Chaffee County, Cockerell **29*b***, 106, 107.

Patula strigosa minor Ckll. Egeria **23**, 175; **28**, 135.

This is probably the same as Prof. Cockerell's var. *minor,* in which case, if the species is recognizable from Cockerell's description, the latter name would supersede Dall's.

Oreohelix cooperi W. G. B. Fig. 4.

Dead shells near Naomi, Black Lake Creek, top of range between Wheeler and Red Cliff, Squaw Creek, Grand River at Glenwood Springs (1 alive), North Mam Creek,

Fig. 4.—Oreohelix cooperi.

near Buzzard Creek (one alive); Plateau Creek, West Fork Clear Water Creek and White Earth, Cockerell Mss. Wheeler and Custer County (Cockerell), Vanatta Mss.

Patula cooperi. Grand River, Binney **5**, 623. Hot Sulphur Springs, Blue River Valley, Lakes in San Luis Valley and N. E. Colorado, Ingersoll **35**, 396. Floyd's Hill, Clear Creek and Canyon City, Ingersoll **37**, 131.

Patula strigosa cooperi. Gilpin Gulch, Williams Canyon, Morrison, Gunnison, Middle Park, North Park, Micawber Mine, Kremmling, Hardscrabble Canyon, Black Lake Creek, Pottery Pass, Red Cliff, Glenwood Springs, Buzzard Creek, Surface Creek, White Earth Creek, Lyons, St. Vrain Canyon, Egeria, near Durango, and Custer, Grand, Routt, Pueblo, Summit, Eagle, Garfield, Mesa, Delta and Gunnison Counties, Cockerell **14**, 102; **22**, 62.

Patula strigosa cooperi. Form *typica,* Ckll., Canyon City, Manitou, etc.; form *trifasciata* Ckll., Mesa County; form *confluens* Ckll., Custer, Garfield, and Mesa Counties; form *elevata* Ckll., Delta Co.; form *depressa* Ckll., Durango; form *major* Ckll., North Mam Creek; form *minor* Ckll., Egeria; Cockerell **12**, 8; **14**, 102; **23**, 175; Binney **7**, 173.

Helix cooperi. Abundant in Williams Canyon, Beauchamp **2**, 53.

Oreohelix cooperi mut. *sinistrorsa.* A sinistral specimen found by Prof. Cockerell's brother in Southern Colorado. Cockerell Mss.; Pilsbry **39**, 83.

We have received dead specimens collected by Professor F. H. Hopkins at Meeker and by Mr. A. Dakan at Muddy Creek, Bear River above Hayden and above Steamboat Springs, and 15 miles north of Craig, all in the western part of the state, and found one lot of five semi-fossil specimens at Boulder. Some of the foregoing records probably refer to *strigosa*, but they are here inserted just as they occur in the literature. The fact that few live ones have been found appears to indicate that it may be on the rapid road to extermination through a considerable part of its range, a matter well worthy of investigation. Professor Cockerell suggests to the writer that its higher spire renders it less fitted than *strigosa* to survive in a semi-arid country, because of the greater difficulty of getting under rocks, etc., to avoid the dry heat. This, however, would not account for the extinction of *haydeni*, which is a depressed form. An investigation of species recently extinct or approaching extinction may throw some light upon recent changes in climate.

Oreohelix cooperi trifasciata Ckll.

Mesa County, Cockerell **12**, 8; **14**, 102; **23**, 175. Gleneyre (S. M. Edwards), Vanatta Mss.

Oreohelix haydeni Gabb.

Glenwood Springs (Silas L. Schumo), Vanatta Mss.

We have just received from Professors E. Bethel and G. L. Cannon about 35 specimens of this species which call to mind Binney's assertion that it must be considered a variety of *strigosa*. The series passes from very strongly ribbed specimens by minute gradation to those almost entirely smooth. The color bands, when not obliterated by bleaching, are as in ordinary *strigosa*. The spire varies from greatly depressed to highly elevated forms, thus connecting *strigosa* and *cooperi*. The specimens referred to above were found fossil together at Glenwood Springs by Miss Mabel Stearns. This affords food for thought, especially when considered in connection with the facts that *haydeni* seems nearly extinct, *cooperi* is apparently extinct through a great portion of its range, and *strigosa* seems much less common in many places than formerly. It is not at all unlikely that further field-work may bring to light the origin and the beginning of the extinction of these forms.

Genus **THYSANOPHORA** Strebel & Pfeiffer

Thysanophora ingersolli Bland.

San Juan, Custer and Mesa Counties, Pilsbry and Johnson **43**, 15. Near Buzzard Creek, West Fork Clear Water Creek, and Ouray, Cockerell Mss. Clear Water Creek and Custer County (specimens from Cockerell), Vanatta Mss.

Microphysa ingersolli. Baker's Park, Cunningham Gulch, Animas Valley and North Park, up to 11,000 feet, Ingersoll **35**, 389, 398. Saguache Mts., Ingersoll **37**, 130. Saguache Mts., Las Animas and LaPlata Counties, Howardsville and Cunningham Gulch, Binney **6**, 170. Western Custer County and Grand Mesa, Cockerell **22**, 62, 65.

Pyramidula ingersolli. San Juan, Custer and Mesa Counties, Cockerell **14**, 103.

We have found a few above Eldora, at an altitude of over 9,000 feet, and four small specimens at Boulder. The latter were accidentally destroyed.

Genus POLYGYRA (Say) Pilsbry

Polygyra monodon Rack. Fig. 5.

FIG. 5.—Polygyra monodon.

Stenotrema monodon, Colorado Springs, Yarrow **68**, 929.
Helix monodon, Colorado Springs, Cockerell **14**, 103.

This should probably not be included in the Colorado molluscan fauna. It is an eastern species, collected long ago and not since reported from this state. We see no reason to doubt the identity, but the specimens must have been accidentally introduced and have evidently not become incorporated into the permanent fauna.

A box full of *P. clausa* Say was found in the Maxwell collection in the University Museum containing a card bearing the word "Colorado," but it was not in Mrs. Maxwell's handwriting and the source of the label is unknown. So conspicuous a species would probably not occur in such numbers without being observed by other collectors, and if Mrs. Maxwell had collected these in Colorado there would probably have been other common land shells with them.

Genus PUPOIDES Pfeiffer

Pupoides marginatus Say.

Pupa fallax Say. South Park, Twin Lakes and Pagosa, Yarrow **68**, 926.
Pupa arizonensis Gabb. (not Pils. & Van.). "From El Paso County, according to Tryon, but not found since." Cockerell **22**, 63. This may be *hordaceus*.
Trinidad (Pilsbry), Vanatta Mss.

Pupoides hordaceus Gabb. Fig. 6.

FIG. 6.—Pupoides herdaceous.

Trinidad (Pilsbry), Vanatta Mss.
Pupa hordacea Gabb. Williams Canyon, Sampson **46**, 102.
Pupa arizonensis W. G. B. and *Pupa saxicola* Ckll., Colorado, Sterki **57**, 4.
Pupa gabbi mexicanorum Dall. Round Mt., Cockerell **29**, 143.
Pupa arizonensis saxicola Ckll. Round Mt., Cockerell, *Zoe*, Vol. II, 1891, p. 18. Placed under *hordaceus* with hesitation, adding, "We know nothing of the Colorado shells called *P. arizonensis* var. *saxicola* by Mr. Cockerell," Pilsbry & Vanatta **44**, 588, 589. Dr. Sterki writes Prof. Cockerell that he has two specimens, dead and somewhat weathered, short as compared with some New Mexico specimens and with slighter, more crowded striæ.

Genus PUPILLA Leach

Pupilla muscorum Linne.

Blue River Valley and Los Pinos Agency, Ingersoll **35**, 390. Twin Lakes, 9,500 ft., Yarrow **68**, 927. Greeley (L. C. Wooster), Estes Park (Rev. E. H. Ashmun), Black Lake Creek (Cockerell), Trinidad (Pilsbry), Vanatta Mss.
Pupa muscorum. Colorado, Pilsbry **38**, 45; Pilsbry & Johnson **43**, 20. Pike's Peak, 10,000 ft., Cockerell **30**, 130. Round Mt., with one specimen of var. *albina* Menke, Cockerell Mss.

We have found it fossil at mouth of Bear Canyon, three miles south of Boulder, and have received specimens collected by Prof. Cockerell at Lake George and by Mr. D. M. Andrews at Magnolia. Prof. E. Bethel has sent us a few specimens found fossil by Prof. Geo. L. Cannon in ancient overwash of the South Platte near Denver.

Pupilla blandi Morse.

Clear Creek, Cunningham Gulch, Animas Valley and Rio LaPlata, Ingersoll **35,** 391. Twin Lakes, Yarrow **68,** 927. Black Lake Creek, Cockerell Mss. Pike's Peak (E. Hall), North Park (E. A. Barber), Estes Park (Rev. E. A. Ashmun), Buzzard Creek, Black Lake Creek, Mesa and Custer Counties (Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Pupa blandi. Colorado, Binney **6,** 188; Dall **34,** 367; Pilsbry & Johnson **43,** 20; Surface Creek, Cockerell **22,** 65.

Form *obtusa* Ckll. "Broader in proportion to its length than the type," near Micawber Mine, Cockerell **24,** 39; Pilsbry & Johnson **43,** 20; Pilsbry & Vanatta **44,** 605.

"The species of *Pupa* are numerous and puzzling. The common species in Custer Co. is *P. blandi* Morse, which presents various forms, one of which Mr. C. F. Ancey, to whom specimens were sent, refers to *P. bigranata* Rossm. Probably they are all referable to *P. marginata* Drap. as varieties." Cockerell **22,** 62.

Collected at Magnolia by Mr. D. M. Andrews; on the Niobrara limestone ridge south of Left Hand Creek north of Boulder by Prof. Cockerell and the writer; at Tolland by Prof. E. Bethel and by the writer at Boulder and Eldora.

Pupilla sonorana Sterki.

Estes Park (Rev. E. H. Ashmun), Vanatta Mss.

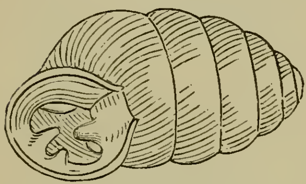


Fig. 7.—Bifidaria armifera

Genus **BIFIDARIA** Sterki[1]

Bifidaria armifera Say. Fig. 7.

Trinidad (Pilsbry), Vanatta Mss.

We have found it fossil at mouth of Bear Canyon south of Boulder but find no published record for the state.

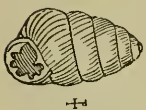


Fig. 8.—Bifidaria pentodon.

Bifidaria pentodon Say. Fig. 8.

Pupa montanella Ckll. Western Custer County, Cockerell **22,** 63 (no description accompanying the latter name, it is a *nomen nudum*, and is in any event a synonym, Pilsbry & Vanatta **44,** 608). Prof. Cockerell says he has since compared his figure and notes and finds the shell to be the real *pentodon* as recently restricted by Pilsbry and Vanatta.

Bifidaria pilsbryana St.

Trinidad (Pilsbry), Vanatta Mss.

Bifidaria hordeacella Pils.

Trinidad (Pilsbry), Vanatta Mss.

Bifidaria procera Gld.

Trinidad (Pilsbry), Vanatta Mss.

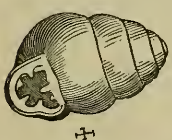


Fig. 9.—Vertigo ovata.

Genus **VERTIGO** Draparnaud

Vertigo ovata Say. Fig. 9.

Twin Lakes and Saguache, Yarrow **68,** 927, 928. Fossil at West Cliff, Cockerell **29,** 143. Trinidad (Pilsbry), Vanatta Mss.

Vertigo ovata antiquorum Ckll. Subfossil at Grape Creek, Cockerell Mss.

[1] The records of *B. pilsbryana, hordeacella* and *procera* have just been received and consequently do not appear in the key included in Part I of this paper.

Vertigo ventricosa elatior Sterki.

One specimen was collected this year at Lake George by Professor Cockerell and identified by Mr. Vanatta.

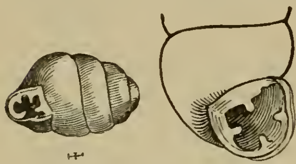


Fig. 10.—Vertigo gouldi.

Vertigo gouldi Binn. Fig. 10.

Colorado, Sterki **54**, 31; Binney **7**, 199. Fossil at West Cliff, Cockerell **29**, 143.

Vertigo tridentata Wolf.

South Park (No. 29667 U. S. Nat'l Mus.), Sterki Mss., **55**, 135; Binney **7**, 196.

Vertigo modesta corpulenta Morse.

Colorado, Dall **34**, 367.

Pupa corpulenta. Los Pinos Agency and divide S. W. of Los Pinos, Ingersoll **35**, 392. Custer and Delta Counties, Cockerell **22**, 62, 65. North Park, Pilsbry & Johnson **43**, 21.

One specimen was collected recently by Prof. Cockerell at Lake George and identified by Mr. Vanatta.

Vertigo modesta corpulenta parietalis Ancey.

Colorado, Pilsbry & Vanatta **44**, 609. Delta and Custer Counties (Cockerell), North Park (E. A. Barber), Vanatta Mss.

Pupa corpulenta parietalis. Black Lake Creek, Cockerell Mss.

Dall includes *ingersolli* Ancey (=*concinnula* Ckll.) and *coloradensis* Ckll. under the name *decora* Gld. (=*modesta* Say) for Colorado, Dall **34**, 367; see Cockerell's comments, **28**, 135.

It would be no great sin to consider the last two synonyms of *modesta.*

Vertigo coloradensis Ckll.

Near Swift Creek. Pilsbry & Vanatta **44**, 603, 609; Cockerell **28**, 135; Sterki **57**, 5.

Pupa coloradensis. Colorado, Cockerell **22**, 63; Brit. Nat., 1891, p. 100; Binney **7**, 191; Pilsbry & Johnson **43**, 21.

Vertigo concinnula Ckll.

Animas Valley, Rio LaPlata and Cunningham Gulch, Cockerell **28**, 135. Custer and Summit Counties, Pilsbry & Vanatta **44**, 600. Summit and Custer Counties and Black Lake Creek (Cockerell), Vanatta Mss.

Vertigo californica Ing. Blue River Valley, Los Pinos Agency, S. W. of Los Pinos, Howardsville, Animas Valley and Rio LaPlata, Ingersoll **35**, 392.

Vertigo decora var. *concinnula* Ckll. Colorado, Dall **34**, 367.

Pupa concinnula Ckll. "Colorado at high elevations. (*V. ingersolli* Ancey, unpublished, with varieties *haydeni* and *accedens* Anc., belong here.)" Pilsbry & Johnson **43**, 21. See Sterki **57**, 5.

Var. *haydeni* Ancey. Cunningham Gulch, distinguished by three parallel teeth on inside of outer wall of aperture, Cockerell Mss.

We recently collected four specimens at Eldora.


Fig. 11.—Vertigo milium.

Vertigo milium Gdl. Fig. 11.

Kremmling, Cockerell Mss.

Genus **COCHLICOPA** (Fér.) Risso.

Cochlicopa lubrica Müll. Fig. 12.

Fig. 12.—Cochlicopa lubrica.

Near West Cliff and Swift Creek, Cockerell **12**, 9; **22**, 62. Buzzard Creek, Cockerell **15**, 360. Plateau Creek and subfossil at Cotapaxi, Cockerell Mss. Custer County, Buzzard Creek and Colorado Springs (Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Cionella subcylindrica L. Clear Creek, Ingersoll **35**, 391.

Ferussacia subcylindrica L. Williams Canyon, Sampson **46**, 102.

Cionella lubrica. White Earth, Dall **34**, 353.

We have found about 20 specimens at Boulder.

Genus **VALLONIA** Risso.

Vallonia pulchella Müll. Fig. 13.

South Park, Yarrow **68**, 932. North America east of the Rocky Mts., Sterki **58**, 16. Rio LaPlata, Dall **34**, 366. Boulder County (Cockerell), Vanatta Mss.

Fig. 13.—Vallonia pulchella.

Helix pulchella. Estes Park, Binney **5**, 623. Blue River Valley, West of Saguache, Los Pinos Agency, Howardsville, Rio LaPlata and North Park, Ingersoll **35**, 399.

We suspect that the early records, antedating the description of *gracilicosta* and *cyclophorella*, probably refer to the latter. Professor Cockerell, however, has recently found true *pulchella* on a vacant lot in Boulder. On the same lot occurs the introduced *Agriolimax agrestis*, which suggests that this *Vallonia* may have been also introduced. One specimen of *pulchella* was found also in Boulder, near Boulder Creek, last spring, by Mr. Sievert R. Rohwer.

Vallonia gracilicosta Reinh.

Trinidad and Simpson's Rest near Trinidad (Pilsbry), Vanatta Mss.

Found fossil at Bear Canyon, three miles south of Boulder, with a number of species which still survive in the region. Some worn specimens collected by Prof. Cockerell at Lake George we refer to this species with some hesitation, and we have received two specimens from Prof. E. Bethel, found fossil by Prof. Geo. L. Cannon in ancient overwash of the Platte River near Denver, associated with several other species.

Vallonia cyclophorella Anc.

North Park (E. A. Barber), Swift Creek, Buzzard Creek, Clear Lake Creek, Divide Creek and Cattle Creek (Cockerell), Vanatta Mss. West Cliff, Sterki **56**, 101; **59**, 272. Pike's Peak, 10,000 ft., Cockerell **30**, 130. Salida, North Mam Creek, Round Mt., North Park and Los Pinos Agency, Cockerell Mss.

Vallonia pulchella costata Müll. Williams Canyon, Sampson **46**, 102.

Helix pulchella var. *costata.* Micawber Mine, Rock Creek, Kremmling, Pueblo County, near Salida, Black Lake Creek, Buzzard Creek and near Cattle Creek, Cockerell **14**, 103. Custer County, Cockerell **22**, 62.

Along the foothills of Boulder County, and perhaps throughout the state, this is our most common land snail and the only Vallonia at all common. It extends well into the mountains, where we have found it near Eldora, 8,500 feet, and Mr. D. M. Andrews collected a few at Magnolia. Probably most of the Colorado records of *pulchella* belong here.

Genus VITREA Fitzinger [1]

Vitrea hammonis Strom.

Colorado, Pilsbry & Johnson **43**, 25. Buzzard Creek, Divide Creek and Black Lake Creek (specimens from Cockerell), Trinidad (Pilsbry), Vanatta Mss.

Zonites viridula Menke. Blue River Valley, Saguache Creek, 20 miles west of Saguache, Cascade Creek in Animas Valley and Rio LaPlata, always at foot of mountains, wet, shaded ground, beside running water, Ingersoll **35**, 393. South Park, Yarrow **68**, 934.

Hyalina radiatula Alder. Custer, Pueblo, Mesa and Garfield Counties, Cockerell **22**, 62, 64. Buzzard Creek, Cockerell **15**, 360.

Hyalina radiatula viridescenti-alba Jeffreys. Custer and Mesa Counties, Cockerell **14**, 101; **22**, 62; Buzzard Creek, Cockerell **15**, 360.

Vitrea radiatula Alder. Subfossil at Grape Creek, Cockerell Mss.

Genus VITRINA Draparnaud

Vitrina alaskana Dall. Fig. 14.

FIG. 14.—Vitrina alaskana.

Vitrina pfeifferi Newc. Head of Gunnison River, Binney **5**, 623. Los Pinos Agency, divide southwest of Los Pinos, Howardsville, Rio LaPlata, head of Mineral Creek and head of Gunnison River, Ingersoll **35**, 394. Ft. Garland and Twin Lakes, Yarrow **68**, 932. Colorado, Binney **6**, 88; Pilsbry & Johnson **43**, 25. East Fork Arkansas River in Lake County, near Cattle Creek, near Mam Mts., Breckenridge and Rock Creek, Cockerell **22**, 62; **14**, 100. Wet Mt. Valley, Northrop, near Zion Peak, West Ten Mile Creek, Straight Creek, Black Lake Creek, near Cattle Creek, near head North Mam Creek, north of Buzzard Creek, West Fork Clear Water Creek, Surface Creek and East Twin Mesa, Cockerell Mss.

Vitrina limpida Gld. Clear Creek, Howardsville and Animas Valley, Ingersoll **35**, 394. South Park, Yarrow **68**, 933. Dillon, Swift Creek, Grand Mesa, Wales Canyon, Cottonwood Gulch, near Mam Mts. and West Fork Surface Creek, Cockerell **14**, 100. Colorado, Dall **34**, 365.

V. pellucida. Custer and Saguache Counties, Cockerell **22**, 62, 64.

Vitrina alaskana Dall. Mesa and Saguache Counties, Black Lake Creek and Buzzard Creek (Cockerell), North Park (E. A. Barber), Vanatta Mss.

This species is rather common from Boulder to an altitude of about 11 000 feet. The finest specimens we have found were collected at Eldora. It seems probable that Dr. Dall's name proposed in his paper on the Mollusks of Alaska, should stand for this well-known species, as *pfeifferi* is said to be preoccupied.

Genus EUCONULUS Reinhardt

Euconulus trochiformis Dall. Fig. 15.

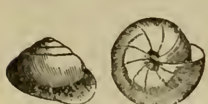


FIG. 15.—Euconulus trochiformis.

Euconulus fulvus Drap. Pike's Peak, 10,000 ft., Cockerell **30**, 130. Rio LaPlata, White Earth, Wet Mt. Valley, West Ten Mile Creek, Straight Creek, Divide Creek, North Mam Creek, North Park, subfossil at Grape Creek, Cockerell Mss. North Park (Barber), Buzzard Creek, Black Lake Creek and Swift Creek (Cockerell), Vanatta Mss.

Zonites fulvus. Hot Sulphur Springs, mouth of Blue River,

[1] **Vitrea alliaria** Drap.

A single specimen was found in February, 1907, by Mr. Guy H. Mason, at Knudson's greenhouse, Boulder, and presented to the University museum by Professor Cockerell. The identity has been confirmed by Dr. W. H. Dall. This being a European species and as yet found only in a greenhouse, it can hardly be considered a member of our Colorado fauna, but is noted here because it may easily become incorporated into the fauna by escaping from hothouses, as *Agriolimax agrestis* was probably introduced.

20 miles west of Saguache, Clear Creek, Howardsville and Empire, most abundant at 9,000 to 10,000 feet, Ingersoll **35**, 393; **37**, 131. South Park and Twin Lakes, Yarrow **68**, 934.

Hyalina fulva chersina Say. White Earth River, near West Cliff, Micawber Mine (10,000 ft.), Kremmling, Egeria, Buzzard Creek, Surface Creek, Divide Creek and Black Lake Creek, Cockerell **14**, 101.

Conulus fulvus. Near Dillon, Cockerell **15**, 360. Custer, Summit, Garfield, Mesa and Delta Counties, Cockerell **22**, 62, 64, 65. Egeria **23**, 175.

Found by Mr. D. M. Andrews at Magnolia; by Prof. Cockerell at Lake George; by Sievert R. Rohwer at Florissant; by Prof. Bethel at Granby; and by the writer at Eldora.

Genus ZONITOIDES Lehmann

Zonitoides arboreus Say. Fig. 16.

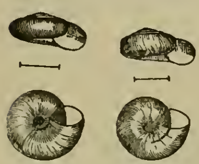


Fig. 16.—Zonitoides arboreus.

Pike's Peak, 10,000 ft., Cockerell **30**, 130. Colorado Springs, Buzzard Creek, Swift Creek and Black Lake Creek (Cockerell), Trinidad and Simpson's Rest near Trinidad (Pilsbry), Vanatta Mss.

Zonites arboreus. Hot Sulphur Springs, Blue River Valley, Howardsville, North Park and LaPlata, Ingersoll **35**, 392. South Park and Twin Lakes, Yarrow **68**, 933. Williams Canyon, Sampson **46**, 102. Wet Mt. Valley and subfossil at Grape Creek, Cockerell Mss.

Hyalina arborea. Near West Cliff, Micawber Mine, Wales Canyon, Slate Creek, Buzzard Creek, Black Lake Creek, Chalk Creek, Divide Creek, Plateau Creek, Kremmling, near Egeria and Manitou, Cockerell **22**, 62, 175; **14**, 100, 101.

H. arborea form *viridula* Ckll. Horseshoe Bend Gulch, Cockerell **14**, 101.

One of the common species along the foothills from Boulder to Lyons, extending up into the mountains, where it was found in some numbers by Mr. D. M. Andrews at Magnolia. Specimens received from Prof. E. A. Kenyon were collected at Florence; some from S. R. Rohwer were collected at Florissant, and one from Prof. Bethel was collected at Granby. We have found it fossil at mouth of Bear Canyon, about 3 miles south of Boulder. The original of the right-hand figure is designated *Z. viridulus.*

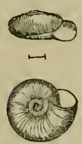


Fig. 17.—Zonitoides minusculus.

Zonitoides minusculus Binn. Fig. 17.

Trinidad (Pilsbry), Vanatta Mss.

Zonites minusculus. Ft. Garland, Yarrow **68**, 934.

We have found it fossil at mouth of Bear Canyon, three miles south of Boulder.

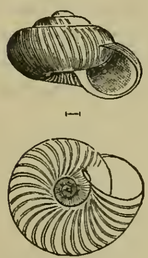


Fig. 18.—Zonitoides conspectus.

Zonitoides conspectus Bland. Fig. 18.

Zonites conspectus. Cunningham Gulch, Ingersoll **35**, 393; Binney **6**, 86, 87.

P. conspecta. San Juan County, Cockerell **14**, 103.

All Colorado records are apparently based upon Ingersoll's specimens.

Genus **AGRIOLIMAX** Morch.

Agriolimax campestris Binn. Fig. 19.

FIG. 19.—Agriolimax campestris.

Northrop, Wet Mt. Valley, Straight Creek, West Ten Mile Creek, Blue River, Naomi, Little Blue Creek and Saguache Creek, Cockerell Mss.

This is our only native species of naked snails or so-called slugs, though there are several varieties or named forms, referred to under the subspecies *montanus.* The records are inserted as we find them, without offering any conclusions as to the wisdom of recognizing the various names. Our own specimens collected at Boulder were identified by Dr. Pilsbry as *campestris.*

Agriolimax campestris montanus Ing.

COLOR FORMS: *Typicus* (typical *montanus*), pale brown, foot-sole pale; *intermedius*, dark brown, foot-sole gray; *tristis*, very dark brown or brown black. Cockerell **15**, 358, 359.

Limax montanus. Grand County, Hot Sulphur Springs, Ingersoll **35**, 389, 394. Colorado, Dall **34**, 366.

Agriolimax montanus. Pueblo and Saguache Counties, Cockerell **22**, 62, 63.

Form *typicus.* Swift Creek, Saguache Creek, near Dillon, Naomi, Two Elk Creek, Buzzard Creek and Little Blue Creek, Cockerell **15**, 359, 360. Custer, Chaffee, Saguache, Fremont, Summit, Eagle, Mesa and Gunnison Counties, Cockerell **14**, 100. Canyon City, Cockerell Mss.

Form *intermedius.* Saguache Creek above Rock Cliff, Surface Creek, West Ten Mile Creek, Wheeler, Black Lake Creek and East Fork Clear Water Creek, Cockerell **15**, 359, 360. Saguache, Fremont, Pueblo, Custer, Summit, Mesa and Delta Counties, Cockerell **14**, 100. Canyon City, Grand Mesa, Wales Canyon, Surface Creek and Short Creek, Cockerell Mss.

Form *tristis.* East Fork Arkansas River in Lake County, Wheeler, West Ten Mile Creek, near Dillon and Surface Creek, Cockerell **15**, 359, 360. Lake, Summit and Delta Counties, Cockerell **14**, 100. Ward, Cockerell Mss.

Agriolimax laevis campestris, var. *montanus*, *castaneus*, *intermedius* and *tristis*, Colorado localities, Taylor **62**, 134, 135. (*Castaneus* is a synonym of *montanus.*)

Agriolimax agrestis Linn. Fig. 20.

Forms *rufesceus*, *brunneus* and *semirufus*, Boulder, Cockerell **30*b***, 90; Taylor **63**, 278, 279.

FIG. 20.—Agriolimax agrestis.

One specimen liberated at West Cliff, Cockerell **14**, 100.

This species was doubtless accidentally introduced, being a European species which has obtained a foothold in the eastern states. They were first found near the University campus at Boulder by Mr. L. C. Bragg, since which time we have found them in several places in the city.

Genus **PYRAMIDULA** Fitzinger

Pyramidula cronkhitei anthonyi Pils.

North Park (Barber), Ouray (Bland), Swift Creek, Black Lake Creek, Buzzard Creek, Divide Creek and Colorado Springs (Cockerell), Vanatta Mss.

Patula cronkhitei Newc. Hot Springs, Blue River Valley and Rio LaPlata, Ingersoll **35**, 397. This probably should be referred to the next species.

Patula striatella Anth. Estes Park, Binney **5**, 623. Hot Springs, Saguache, Clear Creek, North Park and Estes Park, Ingersoll **35**, 397. Empire, Ingersoll, **37**, 131. Twin Lakes, South Park and mountains near Ft. Garland, Yarrow **68**, 931.

Pyramidula striatella. Wet Mt. Valley, Black Lake Creek, Plateau Creek, Rio LaPlata, Crested Butte and White Earth, Cockerell Mss.

We have found it living at Boulder and fossil at Bear Canyon, south of Boulder, have received one specimen collected by Mr. A. Dakan at head of Muddy Creek, in Grand County, others collected at Lake George by S. R. Rohwer, and one collected at Granby by Prof. Bethel.

Pyramidula shimeki cockerelli Pils.

Custer and Saguache Counties, Pilsbry **40**, 85. Rio LaPlata, Cockerell Mss.

Prof. Shimek considers this a synonym of *P. shimeki.* To his paper Pilsbry has made no reply, thus apparently acquiescing therein, but the last specimens placed by him in the collections of the Philadelphia Academy are labeled *P. shimeki cockerelli.* We have found this species abundant at Eldora, altitude 9,300 feet, more strongly striate than specimens from Beulah, N. Mex., and less so than *anthonyi.* Immature specimens of the two species are difficult to distinguish.

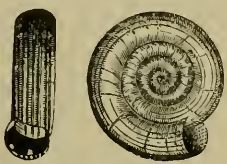


Fig. 21.—Helicodiscus parallelus.

Genus **HELICODISCUS** Morse

Helicodiscus parallelus Say. Fig. 21.

Helix lineatus Say. Animas Valley, Ingersoll **35**, 398.

Possibly this refers to the following species, since described.

Helicodiscus eigenmanni Pils.

Trinidad and Simpson's Rest near Trinidad (Pilsbry), Vanatta Mss.

Prof. Cockerell has presented the University Museum with one specimen from river drift at Trinidad.

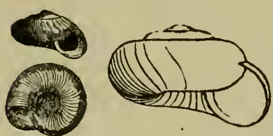


Fig. 22.—Punctum pygmæum.

Genus **PUNCTUM** Morse

Punctum pygmæum Drap. Fig. 22.

P. pygmæa minutissima Lea. Willow Creek, Cockerell **14**, 102.

Genus **SPHYRADIUM** Agassiz

Sphyradium edentulum Drap.

Colorado, Dall **34**, 367; Pilsbry & Johnson **43**, 33. Howardsville (E. Ingersoll), Estes Park (Rev. E. H. Ashmun), Vanatta Mss.

Sphyradium alticola Ing. Colorado, Dall **34**, 367.

Pupilla alticola Ing. Cunningham Gulch and Rio LaPlata, Ingersoll **35**, 391. Either Empire, Colo., or in Utah, Ingersoll **37**, 131. Mam Mts., Cockerell Mss.

Pupa alticola Ing. Western Custer County, Cockerell **22**, 62.

Pupa simplex Say. Colorado, identical with *edentulum,* inhabiting both Europe and America, Sterki **53**, 377.

Vertigo simplex Say. Twin Lakes and South Park, Yarrow **68**, 928.

One specimen was recently found by the writer at Eldora and one or two by Prof. Cockerell at Lake George.

Genus SUCCINEA Draparnaud

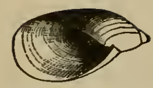


Fig. 23.—Succinea salleana.

Succinea salleana Pfr. Fig. 23.

A few collected at Florence by Prof. E. A. Kenyon were identified by Dr. Bartsch as of this species.


Fig. 24.—Succinea sillimani.

Succinea sillimani Bland. Fig. 24.

Denver, Cockerell **25**, 29, 30.


Fig. 25.—Succinea retusa.

Succinea retusa Lea. Fig. 25.

Succinea ovalis Gld. (not Say). Mouth of Blue River, Ingersoll **35**, 399.

Succinea pfeifferi Rossm. West Cliff, Cockerell **22**, 63.

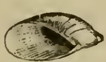


Fig. 26.—Succinea nuttalliana.

Succinea nuttalliana Lea. Fig. 26.

Hot Sulphur Springs and Animas Valley, Ingersoll **35**, 399. Subfossil at Grape Creek. Cockerell Mss.

A few have been received from Prof. E. A. Kenyon, collected at Florence.

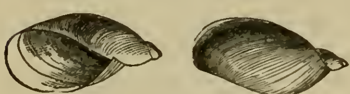


Fig. 27.—Succinea haydeni.

Succinea haydeni W. G. B. Fig. 27.

A few received from Prof. A. E. Beardsley of the State Normal School were collected at Greeley.


Fig. 28.—Succinea grosvenori.

Succinea grosvenori Lea. Fig. 28.

Colorado, Pilsbry & Ferriss **45**, 161; Pilsbry & Johnson **43**, 34. Greeley (L. C. Wooster), Vanatta Mss.

Succinea lineata Say. Estes Park, Binney **5**, 623. Twenty miles west of Saguache, Animas Valley, bank of Bear river and San Luis lakes, Ingersoll **35**, 400. Empire, Ingersoll **37**, 132. Kremmling, Cockerell **26**, 45. Greeley, Cockerell Mss. (Ingersoll's specimens said to be mostly *avara*, Cockerell **22**, 64.)

Succinea lineata form *elongata* Ckll. Type locality Kremmling, Cockerell **24**, 39; **26**, 45.

Succinea mooresiana Lea. Round Mt., Cockerell **26**, 44.

Prof. E. Bethel has sent us a few found fossil by Prof. Geo. L. Cannon in ancient overwash of the South Platte near Denver.


Fig. 29.—Succinea avara.

Succinea avara Say. Fig. 29.

South Park, Fairplay, Twin Lakes and Loma, up to 10,000 ft., Yarrow **68**, 935. Custer, Saguache and Pueblo Counties, Cockerell **22**, 63, 64. Custer County and near Cattle Creek (Cockerell), Greeley (L. C. Wooster), Gunnison County (B. H. Smith), Vanatta, Mss.

Succinea avara compacta Ckll. Type locality Chalk Creek, Cockerell **24**, 39; **26**, 44.

Form *alba* Ckll. Horseshoe Bend Gulch, Cockerell **26**, 43.

Succinea avara vermeta Say. Subfossil at Grape Creek, Cockerell Mss.

A short, globose form at Denver, Cockerell Mss.

We found it living at Boulder, fossil at Bear Canyon and dead at Manzanola, and have received dead shells from Magnolia, collected by Mr. D. M. Andrews; from Granby, collected by Prof. Bethel; from Florissant, collected by S. R. Rohwer, and alcoholic specimens from Monon, collected by E. R. Warren. Some specimens from Davidson's ranch have a decidedly reddish tinge.

FIG. 30.—Succinea rusticana.

Succinea rusticana Gld. Fig. 30.

Hot Sulphur Springs, Ingersoll **35**, 399.

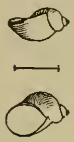


FIG. 31.—Succinea stretchiana.

Succinea stretchiana Bland. Fig. 31.

Large specimens, Pagosa, Yarrow **68**, 936.

Form *major* Anc. Mss. Pagosa, Cockerell **25**, 31.

Specimens "doubtfully referred to *S. stretchiana* Bland," Chaffee County, Cockerell **22**, 63; but see **26**, 46.

Genus LYMNÆA Lamarck

Lymnæa stagnalis appressa Say.

Limnæa stagnalis Lin. Between Animas and LaPlata, Ingersoll **35**, 405. Rio Grande, Loma and Del Norte, Yarrow **68**, 941, 942.

FIG. 32.—Lymnæa parva.

Lymnæa parva Lea. Fig. 32.

Howardsville (Ingersoll), South Park (Wolf), Swift Creek, Custer County (Walker), Baker Mss.

FIG. 33.—Lymnæa humilis.

Lymnæa humilis Say. Fig. 33.

Denver and South Park, Yarrow **68**, 945. San Luis Valley and Howardsville, Ingersoll **35**, 406. Denver, Surface Creek and subfossil at West Cliff, Cockerell Mss.

Limnæa truncatula. West Cliff, Cockerell **14**, 9. Abundant in Custer County, Cockerell **22**, 63.

A specimen collected by Prof. Cockerell at Lake George we refer to this species.

FIG. 34.—Lymnæa obrussa.

Lymnæa obrussa Say. Fig. 34.

Trinidad (Ashmun), Greeley (Shimek), Baker Mss.

Limnæa desidiosa Say. Hot Sulphur Springs and Blue River Valley, Ingersoll **35**, 406. Trout Creek, Yarrow **68**, 944. Greeley, Cockerell Mss.

Abundant in overflow ditches at Boulder, associated with *L. caperata.* A few were collected at Florence by Prof. E. A. Kenyon.

FIG. 35.—L. obrussa modicella.

Lymnæa obrussa modicella Say. Fig. 35.

Limnæa modicella Lea. Collected in Lodge Pole Creek by Chas. T. Simpson, Cockerell **22**, 61.

FIG. 36.—Lymnæa bulimoides.

Lymnæa bulimoides Lea. Fig. 36.

Variety at Denver, Ingersoll **37**, 132. Probably refers to one of the subspecies following.

Lymnæa bulimoides cockerelli Pils. & Fer.

Pool southeast of Denver, Pilsbry & Ferriss **45**, 162.

Lymnæa bulimoides techella Hald.

A few specimens were collected at Florence by Prof. E. A. Kenyon.

Fig. 37.—Lymnæa palustris.

Lymnæa palustris Müll. Fig. 37.

Between Animas and LaPlata, Ingersoll **35**, 406. Georgetown, South Park, Twin Lakes, Saguache and Loma, Yarrow **68**, 942, 943. Decollated form, pond near Black Lake, Cockerell Mss. *Limnæa nuttalliana* Lea. Between Animas and LaPlata Rivers, Ingersoll **35**, 406.

This variable species has been described under several different names. There are slight differences in specimens from different lakes, which would afford an interesting study. We have found none in the streams of this region, but have found it common in lakes of both plains and mountains up to 8,500 feet in Boulder, Weld, and Larimer Counties. It has also been collected by Mr. D. M. Andrews at Magnolia and by Prof. F. H. Hopkins at Meeker, and specimens sent by Prof. E. Bethel are believed to have been collected by Dr. T. W. Stanton at Del Norte. Prof. Cockerell mentions (Mss.) some forms from Greeley resembling forms described from Europe. Specimens from a lake near Ward were called *L. palustris haydeni* by Dr. Pilsbry and "a pathologic form of *palustris*" by Mr. Baker, who considers *haydeni* probably a synonym.

Lymnæa palustris elodes Say.

Chalk Creek, Chaffee County (Cockerell), Baker Mss.

Fig. 38.—Lymnæa sumassi.

Lymnæa sumassi Baird. Fig. 38.

Between Animas and LaPlata, Ingersoll **35**, 405.

We found specimens in some numbers at the head of Lake George and in the pool just below the outlet, which Mr Baker refers to this species, but none anywhere else in the lake. The writer feels much inclined to call them *palustris*, as does Mr. Walker also, in the absence of an opportunity to compare them with the types of *sumassi*.

Lymnæa leai Baker.

Between Animas and LaPlata, Frank C. Baker, "Description of new species of Lymnaea," The Nautilus, Vol. XX, March, 1907, p. 125-127. In Mr. Baker's paper, received since our bibliography accompanying the first part of this paper was printed and consequently not appearing therein, he says: "Easily recognized by its short spire, very large aperture and heavy columellar plait. . . . . It has probably been heretofore identified as a form of the protean species *palustris*, but it is unquestionably distinct from any form of that species."

Fig. 39.—Lymnæa caperata.

Lymnæa caperata Say. Fig. 39.

Its habitat in this region appears to be overflow ditches and sloughs which are dry during part of the year. We have collected it from Boulder to Loveland and have received specimens collected by Prof. E. Bethel at Granby, by Prof. E. A. Kenyon at Florence, by Mr. S. R. Rohwer at Florissant, by Mr. H. W. Clatworthy at Ft. Morgan, by Miss

Voight at Canyon City, and two found by Mr. A. Dakan in a spring near Boulder Falls, in the mountains west of Boulder. In view of the abundance of the species at Boulder and its wide distribution it is surprising to find a dearth of records for the state.

Genus **PLANORBIS** Guettard

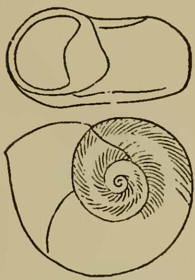


Fig. 40.—Planorbis trivolvis.

Planorbis trivolvis Say. Fig. 40

Saguache, Yarrow **68**, 946.

Helisoma trivolvis. Between Animas and LaPlata and at San Luis Lakes. Ingersoll **35**, 404.

One of the most abundant mollusks in lakes, ponds and some small, sluggish streams from Boulder northward to Crow Creek, dead shells sometimes thickly covering the beaches of old irrigation reservoirs, usually associated with *Physa* sp. and *Planorbis parvus.* We also found great numbers in a mountain lake in Estes Park. Specimens received from Prof. E. A. Kenyon were collected at Florence, and some from Prof. Cockerell were collected at Lake George.

Planorbis trivolis plexata Ing.

St. Mary's Lake, type locality, Ingersoll **35**, 389, 402.

Fig. 41.—Planorbis bicarinatus.

Planorbis bicarinatus Say. Fig. 41.

Lodge Pole Creek, collected by Mr. C. T. Simpson, Cockerell **22**, 61.

We have found a few in Owen's Lake, in a sluggish stream east of Boulder and in northern Weld County, and noted a few in the collections of the State Normal School at Greeley.

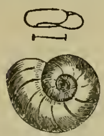


Fig. 42.—Planorbis parvus.

Planorbis parvus Say. Fig. 42.

South Park, Yarrow **68**, 947. Subfossil at Grape Creek, Cockerell Mss. Empire (Pilsbry), Buzzard Creek (Cockerell), North Park (E. A. Barber), South Park (Smithsonian), Trinidad (Pilsbry), Vanatta Mss.

Gyraulus parvus. Hot Sulphur Springs, Arkansas River, 10 miles below Granite, between Rio Animas and LaPlata, St. Mary's Lake and North Park, Ingersoll **35**, 404. Davidson's Ranch, Ingersoll **37**, 133.

Abundant on vegetation, rocks, sticks, etc., from Boulder to Crow Creek, extending into the mountains up to at least 9,000 feet. Specimens received from Prof. E. A. Kenyon were collected at Florence. We have received two specimens from Prof. E. Bethel, found fossil by Prof. Geo. L. Cannon in ancient overwash of the South Platte River near Denver.

Planorbis umbilicatellus Ckll.

Davidson's ranch, Vanatta **65**, 117.

A day spent in searching for this species at Davidson's ranch resulted in great numbers of *parvus*, but not a single *umbilicatellus.* As it is not a case of mistaken identity, has the species disappeared from there ?


FIG. 43.—Planorbis exacuous.

Planorbis exacuous Say. Fig. 43.

A few specimens were found by Mr. D. M. Andrews in a small lake between Magnolia and Rollinsville, in the mountains west of Boulder.

Genus **ANCYLUS** Geoffroy

Ancylus fragilis Tryon.

On boulders in Buzzard Creek, Cockerell **22**, 65.


FIG. 44.—Ancylus parallelus.

Ancylus parallelus Hald. Fig. 44.

North Park, Ingersoll **35**, 405.


FIG. 45.—Ancylus caurinus.

Ancylus caurinus Cooper. Fig. 45.

Collected by Prof. D. W. Spangler in the St. Vrain at Longmont and by the writer in the Big Thompson at Loveland, identified by Dr. Bartsch. One specimen was collected at Ft. Collins by Mr. L. C. Bragg, in February, 1907, and sent to us for identification. This species may be considered *fragilis*, however, as some conchologists consider the two nominal species the same.

Genus **PHYSA** Draparnaud

The Genus *Physa* is in a very unsatisfactory condition. The species are difficult to distinguish from each other, quite variable in form and otherwise, many early descriptions indefinite and early records doubtful. Our experience has been that in submitting collections of *Physa* to different conchologists they will always differ in their identifications of many of the specimens, and all would like to see some genius with sufficient time, material, energy and courage monograph the genus, examining the types so far as possible. The records which follow are submitted with considerable hesitation, and we would not for the world urge anyone to accept them without question.

Physa heterostropha Say.

Hot Sulphur Springs, east of Saguache and between Animas and LaPlata, Ingersoll **35**, 400. Pueblo, Yarrow **68**, 938. Canyon City, Empire, Hot Sulphur Springs, Middle Park and Denver, Ingersoll **37**, 133. Rio Grande and Gunnison River, small variety at West Cliff, Cockerell **22**, 63, 64, 65.

It is quite possible that many or all of these records are erroneous. Until the genus is revised by some one with plenty of time and abundant material it is not safe to say much about the various species, and particularly is this true of the early records. We obtained specimens at Hamblin's Lake, near Hygiene, which Dr. Bartsch assigns to this species.

Physa wolfiana Lea.

Hot Sulphur Springs, described from specimens found in the hot water, but assigned by Ingersoll to *heterostropha*, Ingersoll **35**, 401.

Mr. Bryant Walker writes that he has specimens from the Hot Springs, but that whatever they are, they are not *heterostropha*. Specimens collected by the writer at

Longmont and Loveland were assigned to this species by Dr. Bartsch, but Mr. Walker has compared them with his specimens of *wolfiana* from the type locality and does not consider them the same.

Physa cupreonitens Ckll.

Described from specimens found in a hot spring at Wellsville, Cockerell **22**, 63.

Physa gyrina Say.

Rio Grande, Yarrow **68**, 936, 937. Routt Co., Crandall **32**, 54. Included under *heterostropha* by Stearns **50**, 103.

This seems to be the common species in lakes and ditches at Boulder, Windsor, Gault, Ault and Crow Creek. We have received specimens from Prof. F. H. Hopkins, collected near Meeker, and from Prof. E. Bethel, collected at Denver.

Physa elliptica Lea.

Empire, Ingersoll **37**, 132. Gunnison County, Cockerell **22**, 65.

These records may be *P. gyrina oleacea*, but we have now no way of determining the matter. A few found at Owen's Lake were referred to this species by Dr. Bartsch, but Mr. Walker considers one of them an immature *gyrina* and the others not *elliptica*.

Physa integer Hald.

Collected by the writer from a lake at Windsor and ditches at Boulder, by Mr. H. W. Clatworthy at Ft. Morgan, and by Messrs. G. S. Dodds and Harvey Markman at Hamblin's Lake near Hygiene.

Physa anatina Lea.

Mr. Bryant Walker writes that he has specimens from the South Platte at Denver, collected by Mr. Billips.

Physa cooperi Tryon.

Animas and LaPlata, but both identity and validity of the species doubted, Ingersoll **35**, 401.

Specimens from Loveland and Owen's Lake are doubtfully assigned to this species by Dr. Bartsch.

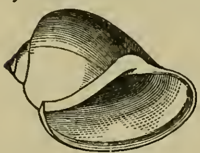


Fig. 46.—Physa lordi.

Physa lordi Baird. Fig. 46.

Specimens received from Prof. A. E. Beardsley were collected by him at the head of Rio Grande Canyon, 12 miles from Antonita, Conejos County.

Fig. 47.—Physa virgata.

Physa virgata Gld. Fig. 47.

Lodge Pole Creek, collected by Mr. Simpson, Cockerell **22**, 61.

A few specimens from near Boulder and Longmont were referred to this species by Dr. Pilsbry but Dr. Bartsch calls them *cooperi*. Mr. Ingersoll **37**, 133, mentions some specimens found by him near Denver which he thought might be of this species.

Physa hawnii Lea.

Specimens from McCall's Lake (Dodds and Markman), Florence (Kenyon) and Canyon City (Miss Voight), are identified as *hawnii* by Dr. Bartsch, but he adds that they may be *occidentale* or even *gabbi*.

Many of the foregoing records of *Physae* may be doubted without seriously hurting the feelings of the writer or his advisers.

Genus **APLEXA** Fleming

Fig. 48.—Aplexa hypnorum.

Aplexa hypnorum Linné. Fig. 48.

Bulinus hypnorum. Grand River Valley and Bear River, Ingersoll 35, 401.

Physa hypnorum. West Cliff, Cockerell 22, 63. Subfossil at Grape Creek, Cockerell Mss.

Numbers were collected by Prof. A. E. Beardsley, of the State Normal School, at Greeley, and by Prof. E. Bethel, of Denver, in an overflow ditch at Granby. The latter has sent us specimens believed to have been collected by Dr. T. W. Stanton at Del Norte.

Genus **VALVATA** Müller

Fig. 49.—Valvata lewisi.

Valvata lewisi Currier. Fig. 49.

Colorado, Dall's "Land and Fresh Water Mollusks, Harriman Alaska Expedition," Vol. XIII, p. 123.

Valvata sincera Say. One specimen at San Luis Valley lakes, Ingersoll 35, 390.

REJECTED RECORDS

Anodonta dejecta Lewis.

Arkansas River, west of 100th Meridian, Yarrow 68, 952; Cockerell 22, 62. This locality is believed to be certainly erroneous. See Simpson 49, 52.

Pisidium pusillum Gmel.

Custer and Saguache Counties, Cockerell 22, 64. This species is European, not reported from elsewhere in America, and in view of the difficulties of the genus and the unsatisfactory status of the western species, it may be safely disregarded.

Pisidium mesæ Ckll.

"A small *Pisidium*, having apparently the same relation to *P. pusillum* that *P. roseum* has to *P. nitidum*, is provisionally called *P. mesæ.* It is from the southern slope of Grand Mesa, in Delta County; it may prove to be but a variety of *P. pusillum.*" Cockerell 22, 65. Apparently described from a single specimen. The description not being sufficient to make it recognizable, as Dr. Sterki writes, especially in such a variable genus, it must for the present be considered a *nomen nudum.*

Helix nemoralis.

Two or three specimens liberated at West Cliff, Cockerell 14, 100. They could hardly become incorporated in the fauna of the state.

Epiphragmophora coloradensis Stearns.

Erroneously credited to Colorado in Dall's list (34, 366), but correctly assigned to Arizona in the text at page 340.

Zonites nitidus Müll.

Carpenter, **10**, 542. Species merely listed in a list of alpine insects. Probably a case of mistaken identity. Record included in Prof. Cockerell's list, **14**, 100.

Vertigo rowelli Newc.

"A species referred by Mr. Pilsbry to *P. rowelli* Newc.," Surface Creek, Cockerell **22**, 65. In a subsequent paper this species is listed only from California and Oregon, the Colorado record being disregarded, Pilsbry & Vanatta **44**, 610.

Vallonia costata Müll.

"West to Colorado." Pilsbry & Johnson **43**, 7. We are aware of no records which may be considered safe. See *V. cyclophorella*.

Lymnæa aff. **rowelli** Tryon.

Rio Grande County, Cockerell **22**, 64. Identity uncertain and cannot now be determined.

Lymnæa ferruginea Hald.

Between Animas and LaPlata, Ingersoll **35**, 406. Recorded with doubt as to identity.

Lymnæa traski Tryon.

Colorado, no definite locality, Ingersoll **35**, 406. A Pacific Coast species. We suspect a mixing of labels or mistaking abbreviation of California for Colorado.

Pleurocera sp.

"Among mollusks Pleurocera and Pisidium were observed in the Pike's Peak lakes." Ward **67**, 143. Probably refers to some species of *Lymnæa*.

Somatogyrus subglobosus Say.

Five specimens from San Luis Valley lakes, Ingersoll **35**, 390. We dare suspect that these were very depressed *Lymnæa bulimoides cockerelli*.

THE SILVA OF COLORADO

II. The Poplars, Aspens and Cottonwoods

By Francis Ramaley

Occurrence and distribution.—The genus *Populus*, which includes the poplars, aspens and cottonwoods, is represented in Colorado by six well-known species. As a rule, these trees grow along river bottoms and in moist canyons but the quaking aspen forms groves on hill- and mountain-sides at various altitudes. Even this species is found only in rather damp soil, and it is often remarked that a given hillside must be moist because there are quaking aspens growing on it. In the plains region it is possible to locate the courses of streams for long distances by the "cottonwoods" which grow along the banks. In Colorado, with its thousands of acres of needle forest, there are few places with forest cover of broad-leaf trees. Such forest areas as do exist are generally small. In the mountains the trees are aspens, and in the plains region they are "cottonwoods." The geographical distribution of the different species of cottonwood is not well known because most people do not distinguish them easily and there has not been a thorough and systematic study of these trees by competent botanists except in a few parts of the state.

Economic value.[1]—In Colorado, up to the present time, the wood of species of *Populus* has been used for fuel and somewhat in the building of fences and sheds. The trees are not very abundant and the supply of such wood soon becomes exhausted. However, there are tracts of bottom-land in the plains region well adapted to the growth of these trees. It may be expected that in time farmers and ranchmen will find that a wood-lot is an important part of a farm and they will grow trees just as now they grow grains and fruit. When more valuable trees such as black locust and hardy catalpa are planted the farmer may well reserve a part of his wood-lot for the rapid-growing native poplars.

[1] For remarks on the economic value of forests in general, and particularly for Colorado, see the author's previous paper in this series—*University of Colorado Studies*, Vol. IV, No. 2, p. 109.

In the eastern and northern United States poplar is used in large amount for the manufacture of paper pulp. The wood-pulp industry may at some time become important in Colorado where pine and spruce can be obtained; mills will then be able to use aspen as well. At various points on the north slopes of mountains in southern and western Colorado there are groves of aspen on land of little use for growing anything else. Since many of these groves are in the national forest reserves, it is to be expected that the aspen will be used for pulp or for other purposes. In view of the increasing scarcity of wood it may be that aspen will be sawed up for crates and boxes, especially light cases such as are used for eggs and fruit.

Poplars and cottonwoods as shade trees.—Nearly all of our native species have been tried as shade trees in the towns and cities of Colorado. However, the common western cottonwood, the balm-of-Gilead and the lanceleaf cottonwood are the most satisfactory. They are well adapted for planting. They are handsome in form; the foliage, especially of the first named, is a brilliant shining green; they grow rapidly and easily endure extremes of moisture and drouth unless these are greatly prolonged. A serious objection to all the poplars is their short life. In thirty or forty years they reach full maturity and begin to die. Hence, when planted for quick results, other more slow-growing and longer-lived trees should be set out at the same time. Sometimes the "cotton" of these trees is so abundant as to cause much annoyance to housewives. However, if only stamen-bearing trees are planted, or else if the cotton-bearers are cut down, there can be no objection raised on this score.

The "Carolina poplar," much planted in recent years, has the same good qualities and the same shortcomings as our native species. The Lombardy poplar, well known to everybody because of its tall, spire-like form, is frequently planted and so also is the silverleaf poplar. The latter is certainly desirable as an ornamental tree.

Autumnal colors.—In the Rocky Mountains there are few trees which show handsome autumnal colors. There are no hard maples and gum trees to turn various shades of orange and red. Hence the colors of the poplars become interesting. The foliage of most of these trees turns yellow and brown in autumn. The common western cottonwood is one of the earliest trees to turn color. As a rule, the leaves of certain large branches become quite yellow while those on other limbs are still green. Later the color becomes general. In mountain districts the quaking aspen becomes a conspicuous feature of the landscape because of the bright yellow of the ripened leaves. Sometimes a single grove will show an orange or pale-red tint. Such an occurrence is by no means common, but when this color is developed a very striking appearance is produced.

Different species of Populus in Colorado.—The species are, for the most part, easily distinguished. However, it sometimes happens that there are puzzling variations. It is also probable that natural hybrids occur and these may not be recognized as such. Anyone wishing to become familiar with the different species should first make sure of the typical specimens in the locality and not until later attempt to determine the occasional abnormal forms. Since some trees are found only in the foothills, some in the plains region and some under cultivation, it follows that one need not look through all the descriptions given below for the particular tree which he is examining. Thus the determination of a species by means of the key and descriptions becomes simplified. It must be remembered that specimens of any of the native species may be found planted as shade trees, but the introduced species are not found except under cultivation. In attempting to distinguish the various species the chief difficulty is to tell the western cottonwood[1] from the cottonwood of the Mississippi Valley.[2] This latter tree is frequently planted for shade. The narrowleaf cottonwood[3] and the lanceleaf cottonwood[4] are also easily confused unless careful attention be given to all the points of the description. The balm-of-Gilead,[5] although belonging to the group with round leaf-stalks, resembles, in form of leaf-blade, the species with flattened stalks, such as the common western cottonwood and the Carolina poplar.

Botanical characters.—The genus *Populus* is one of the two genera of the Willow Family. Salix, the other genus, includes the willows. As a rule there is no difficulty in telling a poplar from a willow. Poplars generally have broad leaves and willows have narrow leaves. But the

[1] *Populus sargentii=P. occidentalis.*

[2] *Populus deltoides.*

[3] *Populus angustifolia.*

[4] *Populus acuminata.*

[5] *Populus balsamifera.*

narrowleaf cottonwood has a leaf as narrow as is found in some species of willow. A glance at the medium-sized branches will show, however, a whitish-gray bark in the poplar and a dark gray in the willow. Both the willows and poplars have the flowers in catkins. The pollen-bearing and seed-bearing catkins are borne on different trees. Those of the willows are erect and those of poplars hang down. Both willows and poplars produce "cotton," but this is more abundant with some species than others. The "cotton" is made up of hairs surrounding the seeds. Since the seed-bearing trees occur in about the same number as the pollen-bearing trees it happens that, in nature, one-half of the trees are cotton-bearers. About twenty-five species of *Populus* are known to science; all belong to the northern hemisphere, but a few species extend well south into Mexico, central Asia and northern Africa. Northward the range is to the Arctic Circle.

Poplars in Colorado during former geologic times.—It is evident from the present wide geographical distribution of the poplars that they are an old group of plants. This is also well shown by the fossil leaves of these trees found in various parts of the world. In Colorado specimens of fossil poplars have been found at Florissant and at Golden. There were at least five species of poplars growing at Florissant during Tertiary times.[1] The fossil remains are very perfect as to the leaves and we can tell the shape, size and veining. Unfortunately nothing is known about the height of the trees and their general habit of growth. However, we may suppose that they looked very much like our cottonwoods of today. Some of the leaves were large, as much as 14 cm. (5½ in.) broad. Other trees had long and narrow leaves, like those of our present-day narrowleaf cottonwood. One species was much like the quaking aspen in the form and size of leaf. It is interesting to know that these poplars of a bygone day are so similar to living species. The climate of Florissant is cooler than it used to be. In those days the poplars grew along with such plants as holly and live oak and persimmon, for fossil remains of these trees occur also at Florissant. At the present time the poplars of Florissant grow with willows, birches, pines and spruces. In fact the species of *Populus* are now nearly all

[1] According to Professor T. D. A. Cockerell, who has kindly placed his notes at my disposal.

confined to the cooler and temperate regions of the world. Only a few occur in the warmer parts. Fossil remains at Golden, Colo., show that five or six species of poplar grew there at a still earlier time than those at Florissant. Thus we may be sure that for thousands and perhaps millions of years the cottonwoods and poplars have been among the more conspicuous trees of this part of the world.

Genus POPULUS

Trees with alternate, undivided leaves, lanceolate to broadly triangular or heart-shaped; the buds with resinous, aromatic scales. Flowers in aments (catkins) without floral leaves. Staminate and carpellate aments on different trees; the aments made up of bracts, each bearing a single flower in its axil; staminate flowers with 8 to 30, or more, stamens; carpellate flowers with 1 pistil, bearing 2 to 4 elongated styles. Fruit a 2- to 4-valved capsule. Seeds small, provided with long, densely matted, silky hairs, the "cotton."

Key to Species of the Genus Populus[1]

A. Leaves white-hairy underneath, more or less lobed. (Cultivated from Europe.)
1. **Populus alba**

B. Leaves smooth, not white-hairy, at least when full grown.

- **a.** Trees tall, spire-shaped, the branches extending upward close to the trunk. (Cultivated from Europe.) 2. **Populus nigra italica**
- **b.** Trees not spire-shaped; branches variously placed.
  - *a.* Leaf-stalk much flattened laterally where attached to blade of leaf. Leaves easily rustled by the wind; blades broad.
    - a. Leaf-blades somewhat circular in outline with short-pointed apex. Bark very white. Tree of foothills and mountains. The "quaking aspen." 3. **Populus tremuloides**
    - b. Leaves rather broadly triangular or somewhat heart-shaped. Native cottonwoods; but often planted for shade.
      - a′. Teeth of the leaf-blades less than 10 on each side. Tree of southern Colorado and southward. 4. **Populus wislizeni**
      - b′. Teeth of the leaf-blades more than 10 on each side.
        - aa. Leaf-blades very broad, often broader than long; toothed all around except at base; tip of blade narrow-pointed. (Our common western cottonwood.) 5. **Populus sargentii**
        - bb. Leaf-blade generally not as broad as long; toothed all around. Young twigs angular, due to development of cork in ridges. (Cultivated from central U. S.) 6. **Populus deltoides**
  - *b.* Leaf-stalk nearly cylindrical or slightly flattened.
    - a. Leaf-blades ovate, abruptly angled at apex; rounded or cordate at base; under surface whitish. 7. **Populus balsamifera**
    - b. Leaf-blades lanceolate or ovate, generally narrowed at base.
      - a′. Leaf-blades rather narrow; often abruptly pointed. Leaf-stalk one-third as long as the blade, or less. 8. **Populus angustifolia**
      - b′. Leaf-blades broader than in the preceding species; ovate or somewhat triangular; mostly long-pointed. Leaf-stalks slender, generally more than half the length of the blade. 9. **Populus acuminata**

[1] This key includes the native Colorado poplars and three other species frequently planted for shade.

Technical descriptions.—The following descriptions of the different species of aspen and cottonwoods give not only the technical characters but also certain information in regard to appearance, habit, wood-structure and uses. Citations are made to the more accessible books of reference, as in the writer's article on the Pine Family published in the preceding number of these *Studies.* The reader is referred to that article for a fuller list of works dealing with the trees of Colorado. In the key and description of species no mention is made of flowers and fruit. These characters are fully described in the books cited. The text figures, except Fig. 2, are all original, from specimens in the University herbarium. Fig. 2 is copied from Sargent's *Trees of North America.* Attention is called to Fig. 1, which shows the true shape of the leaves much better than the figures given by Sargent or by Britton and Brown.

1. **Populus alba** Linn. WHITE POPLAR, SILVERLEAF POPLAR

Leaves broadly ovate in outline, variously toothed, sometimes deeply cleft and resembling in shape those of the soft maple. Young foliage densely white-hairy, the lower surface persistently wooly. Leaf-stalks nearly cylindrical, considerably shorter than the blades.

A medium-sized tree with smooth, light-gray bark and spreading branches. Wood soft, nearly white, somewhat heavier than that of most of the poplars. Numerous varieties of this species are known in cultivation. The roots extend horizontally a short distance below the soil and send up numerous suckers by which propagation is effected.

Native of Europe and Asia. Naturalized by cultivation in the New England and Middle Atlantic States. Planted as a shade and ornamental tree in the towns and cities of Colorado. The trees are usually bent in the direction of the prevailing winds. In Colorado and elsewhere the variety with sharply lobed leaves is often wrongly called "silverleaf maple."

2. **Populus nigra italica** DuRoi. LOMBARDY POPLAR

Leaf-blades rhombic or deltoid, wider than long, crenulate all around; smooth from the first; leaf-stalks equaling the blades in length.

A tall, narrow, spire-like tree with prominent main trunk; the branches ascending and very numerous; bark thick and furrowed. This is a horticultural variety of the black poplar of Europe.

Known only in cultivation. Formerly much planted throughout the United States but now less common. The trees do well in Colorado but may be expected to die at the top as they grow old.

3. **Populus tremuloides** Michx. ASPEN, QUAKING ASP

RYDBERG, *Flora Colo.* 91; COULTER, *Manual* 339; SARGENT, *Manual Trees of N. A.* 154; NELSON, *Key to Rocky Mountain Flora* 15.

Leaf-blades broadly ovate, often nearly circular in outline, short-acuminate at the apex, finely crenulate all around except at the base, 2 to 4 cm. (¾ to 1½ in.) broad, except those at the ends of twigs which are much larger; dark green above, grayish green below. Leaf-stalks about the same length as the blades; slender and laterally compressed.

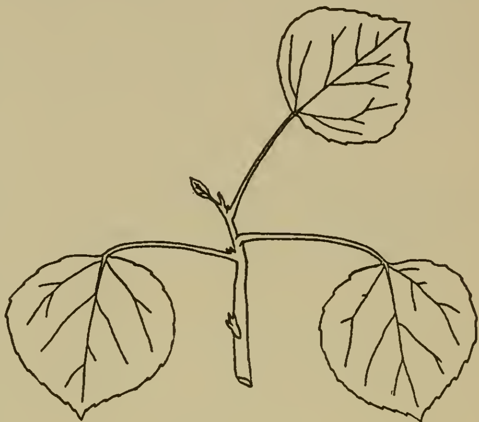


FIG. 1. × ½

A small or medium-sized tree, bearing slender, remote, crooked, horizontal branches. Bark thin, rather smooth, or with wart-like excrescences, white or yellowish green; near the base of old trees the bark is thick, ridged and almost black. Heart-wood yellowish brown; sap-wood nearly white; specific gravity 0.4032. Wood soft, light, close grained, consisting of fibers and small ducts; on account of its structure admirably adapted for the manufacture of wood pulp. Thus far no pulp mills have been established in Colorado to use this wood.

Widely distributed throughout the northern United States and Canada, south to Pennsylvania, Missouri, northern Nebraska, and in the mountain ranges of the West, extending to Arizona, New Mexico and northern Mexico. The light, cottony seeds easily distributed by the wind. Like the lodgepole pine it forms pure growths in places formerly covered with a mixed coniferous forest. It does not extend to the plains region. This tree is sometimes planted for shade in the mining camps of Colorado.

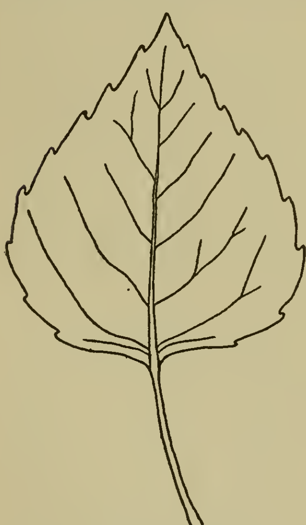


FIG. 2. × ½

4. **Populus wislizeni** (Wats.) Sargent.
COTTONWOOD (FIG. 2)

RYDBERG, *Flora Colo.* 91; SARGENT, *Manual Trees of N. A.* 165.

Leaf-blades broadly deltoid or ovate-orbicular, about 5 to 7 cm. (2 in. to 2¾ in.)

broad; coarsely serrate or crenate with less than ten teeth on each side. Leaf-stalks slender, nearly as long as the blades.

A large spreading tree with stout, light-orange-colored glabrous branchlets. Wood light, soft, used for fuel; specific gravity 0.4621. Bark pale gray-brown, divided into broad, somewhat rounded ridges.

Southern Colorado, south to Texas and Arizona; the common cottonwood of the Rio Grande valley in western Texas and New Mexico. Reported by Rydberg from Arboles, Grand Junction, and Colorado Springs in this state.

5. **Populus sargentii**[1] Dode. WESTERN COTTONWOOD

RYDBERG, *Flora Colo.* 91 (as *P. occidentalis*); COULTER, *Manual* 339 (as *P. angulata*); Sargent, *Manual Trees of N. A.* 164 (as *P. deltoides*, var. *occidentalis*); NELSON, *Key to Rocky Mountain Flora* 15 (as *P. deltoides*).

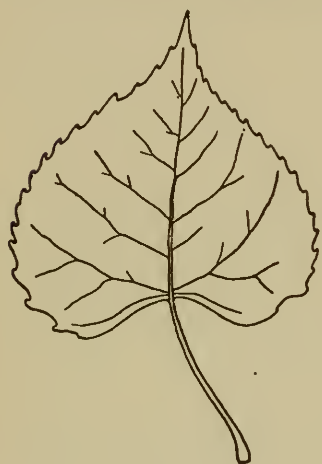


FIG. 3. × ½

Leaf-blades broadly deltoid or heart-shaped, about 8 cm. (3½ in.) broad, with narrow acuminate points; dark green and shining above, slightly paler beneath; toothed or serrate except at base with more than ten teeth on each side. Leaf-stalks laterally compressed in the upper part, somewhat shorter than the blades.

A large or medium-sized tree, the trunk generally divided about 5 meters above the ground into several massive limbs which spread rather widely and give rise to a wide, open crown. Bark of young trees thin, becoming on old trees thick and deeply divided into broad, rounded ridges; that of younger trunks and branches cream-gray or tan color, but dark gray in old trees. Wood light, soft, not strong, close grained; heart-wood brownish, sap-wood nearly white. Used for fuel and in building fences and sheds. Could be used for pulp manufacture.

Rocky mountain region from Canada to Arizona and east to Kansas and Nebraska. This species grows on river bottoms of the plains region and in canyon mouths but not at high altitudes. According to Rydberg's *Flora* it ranges (in Colorado) from 4,000 to 7,000 feet but he reports a specimen collected near Eldora, altitude 8,400 feet. There is very little difference between this species and *Populus*

[1] The author is under obligation to Dr. P. A. Rydberg of New York for information in regard to the name for the western cottonwood. According to Dr. Rydberg the name *occidentalis* is preoccupied by a fossil species. Professor Dode of Paris has named a number of new species from garden material. Of these species *P. sargentii* is our tree. Perhaps some of the others are mere forms of it. Since the other names appear first on the page they have priority. So if they shall prove to be our tree the name *sargentii* will have to be discarded and one of the other names used instead. These are: *P. besseyana and P. henryana.*

deltoides which is found in the Mississippi Valley. In fact our tree was long considered to be merely a western form of that species.

6. Populus deltoides Marsh. COTTONWOOD, CAROLINA POPLAR

It is not necessary to give a full account of this species since it is much like our western cottonwood. Certain differences may be pointed out: the leaves do not have the long narrow point seen in the western cottonwood, they are longer in proportion to the width, and are more finely toothed, and the young twigs are usually ridged longitudinally with corky thickenings.

The name "Carolina poplar" applies to a form of this species which has a symmetrical shape. There is one main trunk from which the branches pass off in a somewhat ascending direction.[1]

This species ranges through the eastern United States and the Mississippi Valley.

7. Populus balsamifera Linn. BALM OF GILEAD

COULTER, *Manual* 339; SARGENT, *Manual Trees of N. A.* 157; (not reported in RYDBERG'S *Flora of Colorado*).

Leaf-blades ovate, serrate, dark green above, pale beneath, very distinctly veined below; abruptly pointed at the apex; rounded or cordate at base, about 6 cm. ($2\frac{5}{8}$ in.) broad, nearly cylindrical, the stalks at least half as long as the blades.

FIG. 4. $\times\frac{1}{2}$

A large or medium-sized tree resembling in general appearance the lanceleaf cottonwood. Winter buds large, coated with a sticky varnish. Bark gray-brown, in old trunks broken into rounded ridges.

Widely distributed in the northern part of North America. Common along the northern boundary of the United States from Maine to Minnesota; extending from Alaska to Oregon, Nevada and Colorado. In sub-arctic regions of northwest America it forms the most characteristic feature of the vegetation; in Colorado confined to canyons and draws in the higher foothills and mountains.[2] The writer has collected specimens at Eldora, Boulder County, Colo., altitude 8,400 feet. Distinguished from the lanceleaf cottonwood chiefly by the whitish under surface of the leaves and prominent reticulate venation.

[1] Mr. George B. Sudworth of the U. S. Forest Service informs me that the differences between the "Carolina poplar" and the typical *P. deltoides* disappear as the trees reach full growth.

[2] The writer is indebted to Professor E. Bethel, of Denver, for information in regard to the distribution f this species and also for a specimen collected near Georgetown.

8. **Populus angustifolia** James. Narrowleaf Cottonwood

Rydberg, *Flora Colo.* 91; Coulter, *Manual* 339; Sargent, *Manual Trees of N. A.* 159; Nelson, *Key to Rocky Mountain Flora* 15.

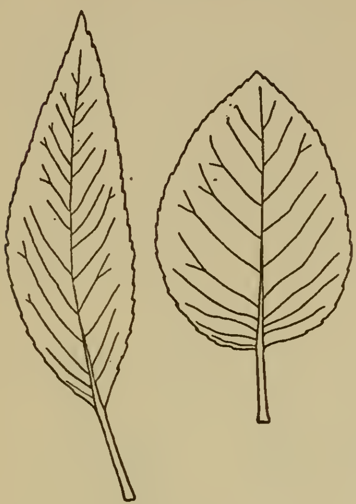


Fig. 5. ×½

Leaf-blades narrowly lanceolate, sometimes broader; varying from acute to obtuse at apex; differing greatly in shape even on the same twig (see accompanying figures); finely toothed all around; usually not more than 2 cm. (¾ in.) broad, but sometimes twice as broad. Leaf-stalks channeled above, short, generally less than one-third the length of the blade.

A rather small, spreading tree, with pale gray twigs, except the youngest, which are yellow-brown. Bark not thick, divided near the base by shallow fissures into broad flat ridges. Wood soft, compact, close grained; specific gravity 0.3912, the heart-wood brown and sap-wood nearly white. Used for fuel.

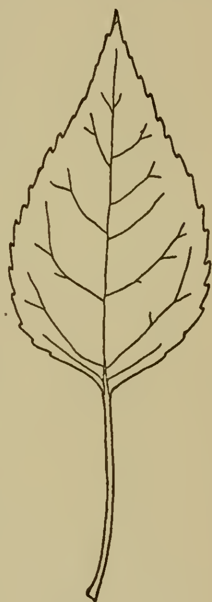


Fig. 6. ×½

River bottoms and canyons from North Dakota to the Pacific coast and south in the mountain ranges from Canada to New Mexico. This is one of the commonest cottonwoods in northern Colorado where it is found on river banks of the plains regions and extending well up in the canyons. Distinguished from other species by the very short leaf-stalks.

9. **Populus acuminata** Rydb. Lanceleaf Cottonwood

Rydberg, *Flora Colo.* 91; Sargent, *Manual Trees of N. A.* 160; Nelson, *Key to Rocky Mountain Flora* 15.

Leaf-blades ovate or broadly lanceolate, variable as to shape and size, crenately serrate, averaging about 4 cm. (1⅝ in.) broad. Leaf-stalks slender, about half or two-thirds as long as the blades.

A rather small tree with compact, round-topped crown, branchlets roughened, the larger branchlets whitish or gray. Wood light, soft, of little value except for fuel.

River bottoms and canyons from Black Hills of South Dakota to the Rocky Mountains and the great basin. Generally confused with the narrowleaf cottonwood, but distinguished by the broader leaf-blade and longer stalk. Not so common as the preceding species; the distribution is somewhat local. Sometimes planted as a shade tree.

Volume IV Number 4

THE UNIVERSITY OF COLORADO STUDIES

FRANCIS RAMALEY
EDITOR

PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

June, 1907

Price, 50 Cents

Volume IV Number 4

THE UNIVERSITY OF COLORADO

STUDIES

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PUBLISHED BY THE
UNIVERSITY OF COLORADO
BOULDER, COLO.

June, 1907

Price, 50 Cents

CONTENTS

THE INCREASE OF DIVORCE

By John Burton Phillips

To understand the increase of divorce it is necessary to take into consideration those forces which are said to be weakening the influence of the family. These forces have been set in motion by modern industrial and social changes, and while not perhaps tending strongly to disintegrate the family, have nevertheless considerably affected its position in the social structure.

The modern family has shared fully in the movement for freedom which has been so characteristic of the last hundred years. Today the family is a sort of free government. The children are ruled by other methods than by the rod. The absolute power of the father is gone. Each member of the family in some degree takes part in its government. The development of liberty in the family is also apparent in the legal position of the wife. Her property is now her own and marriage does not interfere with her rights to its control.

The same change appears in the recognition of the rights of children. Various laws restrict the father's control over them. The parents are compelled to send them to school, and a great movement is now under way to restrict their employment in industry till they are sixteen years of age. This legislation is an outgrowth of the idea of liberty, and the result is the limitation of the father's power in the home.

It is also probably true that modern children are less respectful toward their parents than was formerly the case. The children of American parents are said to be less respectful than those of European. Whatever truth there may be in this is perhaps due to the fact that America is a democratic country and in such a country where classes are not sharply defined children are not likely to show the respect for parents which they display in older and more settled countries where society is more nearly in a static condition. In European countries the boy is as a rule brought up to follow the vocation of his father. He does not try to get out of his class. He therefore thinks differently of the business his father has followed and consequently of his father than do children in the United States. Here the children are taught to learn a trade or to follow a profession superior to that of the father. The boy who from childhood is taught to think that his father's trade of brick-laying is not good enough for him, but that he is to become a physician, is not likely to think his father a great man. Every man in America urges his son to do something better than he himself has done and this is wise. It is the glory of the American national life that the children are filled with the ambition to rise higher than their fathers have risen, but it comes at the expense of that respect which is almost veneration in countries where the son does not try to rise above the level attained by his father.

Since the invention of machinery has opened to women various industrial opportunities, they have become less dependent and the age at which marriage takes place is more advanced. The effect of this is a diminution in the marriage rate of nearly all countries for which statistics are available.[1] Hence, the importance of the family has been somewhat lessened. Women prefer marriage to industry, but since they are able in industry to make a living for themselves, they use greater care in the acceptance of a husband than was the case when they were more dependent. There is some advantage in this as the result is a more wholesome family life. There is every reason to believe that the family life of today is greatly superior to any that existed at any previous time.

Another reason for the decline in the importance of the family is to be found in the fact that marriage is an economic drawback. As a rule when a bachelor marries he finds that the expense of living is multiplied about two and one-half or three fold. Rents are very high and to maintain a home is an expensive luxury. While a home is worth all it costs, it is simply beyond the reach of the young man working in the city for sixty dollars a month. Then, too, the benefits resulting from increased salary due to marriage are scarcely worth considering as but a small percentage of firms will raise the salaries of their employees when they marry. From a purely financial point of view the young

[1] Bailey, *Modern Social Conditions*, p. 139. For statistics of marriages in Massachusetts, see *Mass. Labor Bulletin*, No. 44, p. 459 (December, 1906).

man on small salary is worse off after marriage. If the marriage results in children, it may be that he will be unable to maintain his home in those parts of the city where he lived before marriage, for in many of the desirable sections of the great cities houses will not be rented to families with children. This is especially true of New York City.

The economic disadvantage of marriage is somewhat intensified by the current matrimonial ideal. This ideal is in part the result of the great increase of wealth in the United States during the last two or three decades. The middle class has become rich and a great multitude of women have had leisure thrust upon them. As far as the home is concerned, wealth transmutes itself into the maintenance of an establishment. Hence the idea now so prevalent that a home means a servant and leisure for the wife to devote herself to more or less elaborate social functions. This entails an additional expense upon the husband which he is not always able to bear and brings him to a fuller realization of the economic burden involved in marriage. It is not difficult for persons married and having but a small income, and desiring to realize the more ambitious matrimonial ideal to think of divorce when the family ship begins to encounter the storms of the matrimonial sea.

Some of the more conservative forces tending to maintain the coherence of the family have been considerably weakened by the social changes incident to modern progress. Public opinion which formerly frowned severely upon easy dissolution of marriage has changed very much in its attitude on this question during the last half-century. Along with the amazing development of the idea of individual liberty it has been impossible for public sentiment to recognize such a movement as the independence of woman and not at the same time sanction divorce more often than in the earlier times. Consequently, the force of public sentiment tending to hold the family together has weakened.

In former times the church had much to do with strengthening family ties, and it is still powerful in this respect though not in the same degree as in the past. The Catholic church sanctions no cause of divorce and the Protestant church but one. Though the influence of the church in this respect has weakened, it is clear that were it not for the pressure brought to bear upon them by the religious agencies, many families would long since have sought the divorce courts. The increase of individual liberty of thought and action, however, has made the modern world heed in lessening degree the commands of ecclesiastical authority.

Such are the principal causes that are said to be weakening family ties and leading to an increase in the number of divorces. Whatever the effects of these causes, it is clear that the number of divorces has greatly increased. This increase is not confined to any one country, but like the diminishing birth-rate is a phenomenon common to all civilized nations during the last half-century.

From 1867 to 1886, the only time in which divorce statistics for the United States have been collected, the number of divorces increased about 350 per cent. in Belgium, 200 per cent. in England, 100 per cent. in France, and 157 per cent. here. During the same period our population increased about 60 per cent.[1] It is thus apparent that divorces have increased much more rapidly than population both in this and in other countries.

Number of Divorced Persons to Every 100,000 of the Population[2]

Statistics for 1886

Ireland	.28
Italy (1885)	3.75
England and Wales	3.79
Canada	4.81
Australia, New Zealand and Tasmania	11.14
German Empire	25.77
France	32.51
Switzerland	64.49
United States	88.71
Japan	608.45

The most curious feature of this table is the variation in the divorce rate. Catholic Ireland has the lowest rate and although Protestant United States has been popularly supposed to excel in affording opportunities for the severance of the family tie, it is surpassed by non-Christian Japan. During the year 1886 there were 315,311 marriages celebrated in Japan and during the same year 117,964 divorces were granted.[3] The number of divorces exceeded one-third of the number of marriages.

[1] *Report of the Commissioner of Labor*, 1889, Marriage and Divorce, pp. 140, 998, 1007, 1017. In Massachusetts, from 1860 to 1904, population increased 140 per cent., marriages 109 per cent., and divorces 598 per cent. *Mass. Labor Bulletin* No. 44, p. 460 (December, 1906).

[2] Willcox, "Vital Statistics," *Pol. Science Quarterly*, Vol. VIII, p. 78 (March, 1893).

[3] *Ibid.*

Some explanation of the high divorce rate in Japan may be found by examining the grounds for divorce in that country. The following are the causes for which the husband may obtain a divorce: (1) if the wife is disobedient to her foster-parents, (2) if barren, (3) if licentious, (4) if jealous, (5) if diseased, (6) if she steals, (7) if she talks too much.[1] It is thus apparent that any married man may have a divorce at almost any time according to the laws of Japan.

There are also great fluctuations of the divorce rate in the American states. In 1880 the number of marriages to one divorce was in Delaware 5542, North Carolina 3149, Louisiana 1630, Virginia 1743, New York 1152, Utah 219, Montana 180, Wyoming 173, Nevada 170, Colorado 136. This ratio is also higher in cities than in rural districts or the country as a whole. In the cities of Europe the rate is usually three or four times as high as for the entire country. In Hamburg and Berlin the rate is three and one-half times as great as for Germany.[2]

A higher divorce rate might be expected in the cities and the newer states of the West.[3] The restless and discontented are to be found in these localities where life is more inviting to them than in older and more settled regions. A more intense democracy is also found in the newer states and this helps to swell the divorce rate there.

It is in the newer countries that divorces are most numerous. Here society is in a dynamic condition and the liberty of the individual is most strongly emphasized. Hence the legal system allows easy divorce. Spain forbids both divorce and legal separation. Italy has legal separation but no divorce. England grants separation or divorce for the adultery of the wife, but only separation if it is the act of the husband.

[1] Griffis, *The Mikado's Empire*, Vol. II, p. 557.

[2] *Report of the Commissioner of Labor*, 1889, Marriage and Divorce, pp. 148, 1020 *et seq.*

[3] The divorce rate in Japan is exceeded by the rate in certain counties of North Dakota.

		MARRIAGES TO ONE DIVORCE
Japan	1886	2.67
Cass County, N. D. (Fargo)	1895	2.76
" " " "	1896	1.91
" " " "	1897	1.89
" " " "	1898	1.71
" " " "	1899	2.36
" " " "	1905	18.39

The decline in the rate is due to the law enacted in 1899 requiring twelve month's residence before application for divorce. A still higher rate might possibly be shown for certain counties of South Dakota if figures were available. Coulter, "Marriage and Divorce in North Dakota," *American Journal of Sociology*, Vol. XII, No. 3, p. 411 (November, 1906).

The same rule prevails in Canada. The eastern and southern states are conservative and grant few divorces. In New York adultery is the only cause. South Carolina grants no divorce. In the western states divorces are mostly granted for the three causes, desertion, cruelty and adultery. As a rule three-fourths of the divorces have been granted for these three causes.[1] One of the defects of the law is that it does not define cruelty. All sorts of definitions have been given by the courts. Failure to take wife out riding, talking late at night, snoring in one's sleep, have each been defined by the court as cruelty and a divorce granted. In the state of Washington there was a law in force in 1886 by the provisions of which the judge might grant a divorce if in his discretion it was the best thing for the parties concerned.

This elasticity in the interpretation of the meaning of the word cruelty, and certain lax laws of residence in the various western states have led to what is known as migratory or carpet-bag divorce. Persons in the eastern states desiring a divorce migrate to the West, acquire a residence, secure a decree and then return to their original state. This is one of the causes which tends to swell the number of divorces granted in the western states though it does not fully account for the high rate there. South Dakota has the most unenviable record in this respect. It had for a number of years a law which allowed a divorce to be granted after a residence in the state of only ninety days. Great numbers of New York and other eastern people migrated to this state and secured divorces. At the present time the required residence before application for divorce in South Dakota is one year.[2]

Various proposals for the reform of the divorce evil by legislation have been brought forward. Among them the best known are, perhaps, restriction of divorce, of remarriage after divorce and restriction of marriage. Few students of the question will agree that any of these proposals is practicable.

As to the restriction of divorce by law, it is generally conceded that law can do little except by making divorce expensive. In this way law

[1] In California, Indiana and Michigan great numbers of divorces are granted for non-support, but this is not a cause for divorce in all states.

[2] For a number of years the required residence in South Dakota has been six months, but in March, 1907, the present law was enacted.

can effectually limit the number of divorces. It has been pointed out that from 1867 to 1886, 328,716 divorces were granted in the United States, while during the same period only 135 were granted in Canada. England also has a very low divorce rate. In both of these countries divorces cost several hundred dollars each. This is the principal reason why they are so few. As far as experience goes, this is about the only way in which legislation will greatly lessen the number of divorces. Few would advocate the restriction of divorce by increasing the expense of such litigation.

As to the restriction of the remarriage of divorced persons by law it may be said that this is considered an unwise measure by those students who have given most attention to the problem. At the tenth national conference of the state boards of commissioners for promoting uniformity of legislation in the United States, it was decided not to recommend the enactment of such legislation to the states. The committee entrusted with the preparation of reform divorce laws recorded its opposition to legislation restricting the remarriage of divorced persons in the following words:

> The evident intent of these statutes is to prevent the guilty party from entering into another marriage. He having been unfaithful to the obligations of the first marriage, it is presumed that he is unfit to enter into a second marriage unless he reforms. But such prohibition is in fact a restraint of marriage. It leaves at large a person who by false representations may induce an unsuspecting woman to enter into a void marriage; or if this does not occur, the unfortunate defendant who cannot marry is tempted to continue adulteries without incentive to reformation. A prohibition which restrains marriage, encourages adultery, leaves the party in a position to contract void marriages and takes away a natural incentive to reformation, should be held contrary to public policy. These considerations are sufficient to justify the repeal of such statutes.[1]

Divorces are probably not sought for the purpose of remarriage in any such degree as is popularly supposed. Statistics seem to show that divorced persons are scarcely more apt to remarry than are the widowed. There are no statistics of the remarriage of such persons in the United States but in Switzerland the data have been collected.

[1] NELSON, "Divorce and Separation," p. 566. *Report of Tenth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1900, p. 46.

REMARRIAGE OF DIVORCED PERSONS IN SWITZERLAND[1]

Time between End of First and Beginning of Second Marriage	Of 1000 Widowers Remarrying within Ten Years, Number Remarrying Each Year	Of 1000 Such Divorced Men, Number Remarrying Each Year	Of 1000 Such Widows, Number Remarrying Each Year	Of 1000 Such Divorced Women, Number Remarrying Each Year
Less than one year	323	300	95	194
One year	260	255	264	282
Two years	136	151	152	166
Three years	82	106	132	127
Four years	48	53	91	68
Five–nine years	108	101	196	125
Ten years	43	34	70	38
Total	1000	1000	1000	1000

This table shows that in Switzerland divorced men are not more likely to remarry than widowers, while divorced women remarry during the year in which the divorce was granted at a rate about twice as great as that of the widows during their first year of widowhood. In explanation of the higher remarriage rate of divorced women than of widows, it might be pointed out that widows are more likely to be mothers with children than are divorced women and this lessens their chance of remarrying. If divorce is sought for the purpose of remarriage, it would seem that divorced men would remarry at a greater rate during the first year after the divorce is granted than widowers during their first year of widowhood. But the figures seem to show that they do not. Similar results appear in the statistics of Holland and Berlin. If, therefore, divorce is not sought in any great degree for the purpose of remarriage, restrictions of the remarriage of divorced persons will not tend greatly to diminish the number of divorces.

Restriction of marriage is bad for the morals of any community. About the middle of the last century, Bavaria enacted legislation requiring all men desiring to marry to show legal evidence that they could support a wife and family. In a few years the number of marriages fell

[1] Bertillon, "Fate of the Divorced," *Journal of Royal Statistical Society*, Vol. XLVII, p. 521, September, 1884. Given in Willcox, "The Divorce Problem," *Columbia University Studies*, Vol. I, No. 1, p. 27.

In Connecticut, during each of the years 1889 and 1890, about one-third as many divorced persons remarried during the year as were granted divorces. Howard, *History of Matrimonial Institutions*, Vol. III, p. 219.

greatly, and the number of illegitimate births increased enormously till the illegitimates were one-fourth of all children born. Alarm seized the Bavarians and in 1861 the law was repealed. Marriages increased from 38,000 to 59,000 annually and remained at this high figure for several years. The number of illegitimate births greatly decreased.[1]

There are, however, certain mild restrictions on marriage which it might be wise to enforce in the interest of public morals. It is possible to make it too easy for persons to marry. A marriage ceremony should be surrounded with a certain amount of formality, for this tends to prevent haste and recklessness in contracting matrimonial alliances. The opportunity to marry secretly is not good for the public nor the parties concerned. Neither is the common-law marriage—the simple living together of a man and woman without other ceremony—although it has the sanction of Benjamin Franklin and George Eliot. New York has passed a law declaring common-law marriage illegal. In recent years a number of instances have occurred in which, soon after the death of a well-to-do man, an adventurous woman has appeared and claimed to be his common-law wife deserted before the days of his prosperity. Such an adventuress then brings suit against the estate, and is perhaps bought off by the legitimate heirs.

What is known as the Gretna Green marriage—the young couples running away from home to a place where marriages are easily celebrated and no questions asked—is a debasing element in our society. St. Joseph, Michigan, has been a Gretna Green for Chicago for a number of years, and here a great many marriages have been clandestinely celebrated. The couple have repeatedly requested that the names be not given out. This sort of marriage can be prevented by a law requiring a license to be taken out in the county where one of the parties resides. Requiring a license is not effective if it may be taken out anywhere. Michigan has had a law requiring licenses for a number of years, but it is not such a law as tends to check the migration of persons to St. Joseph for the purpose of marrying secretly. If the license must be taken out in the county where one of the parties resides, runaway marriages will

[1] Willcox, *The Divorce Problem*, p. 60.

be less encouraged. Moreover, such a requirement is no restriction on those who honestly desire to marry.

Of late there has been quite a literature on the subject of divorce from the biological point of view. These writers claim that children should be born in the best of family conditions and that if the husband and wife can only tolerate each other and have no affection, it is for the best interest of society to have them separate and remarry other and more congenial persons. Thus, it is said, healthier children will be born. It has also been contended that the woman who is married to an insane, epileptic or drunken husband, and who bears children by him, commits a crime against society. There is probably some truth in this doctrine, but it seems that it is easily carried to great extremes. Whether the evil to society from children born in families like those described above is greater than the evil from children born of parents on whom the binding effect of the marriage tie is very slight may well be questioned. From an evolutionary point of view, it is not difficult to believe that a society might be developed that would have but scant regard for the marriage vows.

The worst thing about the question of divorce in the United States is the unsettled condition of public sentiment in regard to it. At present there is no agreement in regard to divorce in the laws of the various states, nor is there much scientific study of the question. The practical thing to be done is to ascertain some of the remedies that are likely to be effective in checking reckless divorce and in creating a more sound and healthy public sentiment concerning it. Rather than any specific reform advocated to give immediate results, it seems that the remedies are general and indirect. Some of the measures that will, perhaps, in the long run tend to lessen the number of divorces are the following:

First, the growth of the romantic ideal. By this is meant that each person shall be free to follow his own inclinations in the selection of a husband or wife. A marriage is more apt to last longer if the parties to it are allowed full freedom in the choice they make. Especially is this true in a democratic society where the ideal of the political system is the opportunity for each individual to develop in his own way. Such being the case, everything that increases the opportunities for young men and women to know each other, will lead them to make wiser selections of their life mates.

Of the various agencies affording opportunities for young people to become acquainted, the public educational system is the most important. Of this system the high school is the greatest factor. It is to be regretted that so many of the boys do not remain in the high school to complete the course. It is hoped that the insertion into the curriculum of industrial studies, studies that will prove immediately useful in earning a living, will in the future tend to attract the boys and young men to these courses and incidentally enlarge their acquaintance with young women. It is perhaps this feature that constitutes one of the chief advantages in coeducation.

The public school does not exist solely for the purpose of teaching certain subjects. It is a great democratic institution and the enlargement of acquaintance among the young men and women is one of its great services. The social feature of education creates a larger field from which to select the future husband or wife and thus makes for the stability of the family. Ruskin said a man should know a woman seven years before he married her and our system of education makes this almost possible.

Second, obstacles to the employment of women in commerce and industry should be removed. Women go into industry to become in some degree independent and also for the sake of the social opportunities that come to them while employed in this field. Therefore, everything that tends to reduce their wages, or make less inviting the conditions under which they work may lead young women to marry recklessly in the hope of getting a home. If, as seems to be the tendency, non-support is to be dropped from the list of causes for which divorce may be granted, improvement in the conditions of woman's labor is highly important.[1] Higher wages and the restriction of child labor are therefore greatly to be desired.

Third, some improvement should be made in the law under which divorces are granted. There has been much agitation for a uniform law

[1] *Report of Ninth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1899, p. 73.

and it is probable that such a law might have some effect in tending to check migratory divorce. It would also prevent much of the confusion which at present results from the conflict of laws concerning divorce in the various states. It is doubtful whether such a law would tend to check divorce greatly or reduce the number of divorces now granted in the most liberal parts of the country to the number which are annually granted in the New England states or New York. The evidence is all against the idea that uniformity of law on the subject of divorce tends to even up the number of divorces granted in the various parts of the country. Switzerland adopted a uniform divorce law in 1876. Ten years later, in 1885, Appenzell, Outer Rhodes, one of the cantons, had a divorce rate forty-nine times greater than that of Unterwalden. The same differences in different parts of the country existed as they did before the law was enacted.[1]

To the passage of a uniform divorce law by Congress, legal opinion seems to be opposed. Such a law is considered impracticable. It is claimed that it would lead to federal usurpation of the whole subject of domestic relations and still further congest the federal judiciary. "The federal government can never assume jurisdiction of marriage and divorce in the slightest degree, without absorbing eventually all the power incidental to the subject including family relations, property relations of husband and wife, guardianship of minors, custody and maintenance of children, legitimacy," and domestic relations generally.[2] Such are the views of the state boards of commissioners for promoting uniformity of legislation in the United States and also of the national congress on uniform divorce laws.[3]

Probably the best law that has been proposed is one requiring a two-years' residence in the state before application for divorce is allowed. It also provides that the case shall be heard in open court and before the judge personally. The court is given discretionary power to appoint someone to represent the state in uncontested cases, and cross-examine

[1] Willcox, *The Divorce Problem*, p. 59.

[2] Snyder, "The Geography of Marriage." Quoted in *Report of the Ninth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1899, p. 25.

[3] *Proceedings of the National Conference on Uniform Divorce Laws*, Washington, 1906, p. 52.

the applicant as is done with witnesses in ordinary suits at law.[1] These are desirable reforms. The greatest evil with the procedure in granting divorces at the present time is the secrecy with which the proceeding is surrounded. In many states it is not the practice for the judge to hear the evidence himself. He usually appoints a master in chancery or referee to hear the evidence and make a report to him, and on the evidence in this report grants the decree. The master in chancery or referee frequently hears the evidence in some lawyer's private office where no one appears but the plaintiff and one or two witnesses and as a result few know anything about it till the judge acting on the report of the master or referee has granted the decree desired. If the applicant were obliged to tell the story of alleged matrimonial wrongs in open court and at the same time be questioned by an officer representing the state, it is probable that many persons who now seek divorces for whimsical causes would be content to abide in the friction necessarily resulting from all married life.

There are various views of the effect of increasing divorce. Some consider it as an indication of the disintegration of society; others offer a more optimistic explanation. In so far as the increase of divorce grants greater liberty to woman, it means her elevation. It is part of the movement that has granted to woman the right to live on a higher plane than was possible in the earlier days. When the possibility of divorce is open to every married woman, it is quite likely that this tends in some degree to protect her from harsh treatment at the hands of the husband. In no other country is the position of woman so much respected as in the United States, and it may be that this respect is in part due to the privilege our women enjoy to be divorced from the husband who will make their lives unhappy.

It is certain that societies with many divorces are not more immoral than those societies that grant few or no divorces. Though Italy grants no divorce, it is not more moral than England. No one will maintain that the United States is less moral than Europe, although its divorce rate is very much higher. Nor is it true that the eastern and southern

[1] *Report of the Ninth National Conference of State Boards of Commissioners for Promoting Uniformity of Legislation in the United States*, August, 1899, p. 14.

states which grant few divorces are more moral than the northern and western states where divorces are more numerous. If we judge by the age of consent, this has generally been higher in the northern and western states. Until quite recently, South Carolina which grants no divorce fixed the age of consent at ten years.[1] It is true that the increase of divorce has not as yet indicated a decay of morals.

From the above study of the principal features of the divorce problem, it appears that the modern increase in family dissolution is a result of the movement for greater individual liberty. As we are still in a period of transition, it is likely that in the future there will be some increase in the number of divorces. It is unlikely, however, that the increase will seriously menace the family as an institution. After we have passed the transition period of liberty and our society has become more settled, divorce will probably cease to increase. It seems hardly probable, however, that modern society will ever revert to a condition when divorce will be granted for but one cause.

[1] HOWARD, *History of Matrimonial Institutions*, Vol. III, pp. 198–203.

THE ENGLISH CHURCH AND THE LAY TAXES OF THE FOURTEENTH CENTURY

By James F. Willard

The later Middle Ages witnessed in England the introduction of taxation upon a national scale, which reached, at the same time, most of the classes and the greater part of the wealth of the kingdom. This was, however, only after a long period of experiment and failure with other and less comprehensive forms. The old land taxes, the danegeld and the carucage, had proven inadequate, feudal levies only reached at best a limited number of people and the tallage was only levied upon the towns and lands within the royal demesne. Yet the total revenue from these taxes and from the more permanent sources of income, such as those from the courts and the sheriff's ferm, was insufficient to supply the needs of the government. Gradually because of its manifold advantages, the taxation of personal property superseded the older forms. This new plan of taxation, first introduced by Henry II, reached all classes of laymen, the villein, the freeman in town or country and the upper classes. It was assessed upon all kinds of movable goods in or about the homes of the people, their grain, cattle, household utensils or goods for sale. Such taxes, or subsidies, were granted in varying percentages of the value of this personal property, a tenth, a fifteenth, a twentieth or other rate. In the early fourteenth century it became customary to make a distinction between the borough and the county rate, the former being always the higher. After the year 1332 this became stereotyped, the boroughs always paying a tenth, the counties a fifteenth.[1]

When, during the reign of Henry III, this new plan of taxation had become a permanent part of the system of gaining a revenue for the government, the personal property of the clergy, always excluding certain articles in use in the churches, was taxed with that of the laity. At first

[1] The question of the real as opposed to the theoretical rate of taxation cannot be discussed in this paper. The assessments of the thirteenth and the fourteenth centuries like those of to-day seem to have been at times nominal. Only on this basis could these extremely heavy levies have been borne.

there seems to have been no attempt made to include their spiritual property or revenue, their tithes, oblations and other strictly ecclesiastical sources of income, within the assessment of the lay taxes. These, their spiritualities, are always distinguished from their temporalities, their lands and rents. The latter they owned as any layman might hold them. During the thirteenth century the popes began to demand taxes levied upon the income from both the temporalities and spiritualities of the clergy of England for crusades or for the expenses of the papal court. Following the example of the head of the church, Henry III, from time to time, demanded similar grants from the clergy for the national expenses. In response to these demands, the clerical estate, though often reluctantly, conceded taxes upon its revenues both spiritual and temporal.

This process of development was brought to a sudden close in the year 1291. In that year, the twentieth of the reign of Edward I, upon the command of Pope Nicholas IV, there was taken an assessment of all of the revenues of the clergy of England, in order that a tenth of the same revenues might be used for the support of a crusade to the Holy Land. The results of this assessment were set forth in full in the book known as the "Taxatio Ecclesiastica."[2] This valuation of ecclesiastical property was accepted by the king as the basis for all future grants by the clergy down to the time of Henry VIII. In the fourteenth and fifteenth centuries, a grant of a tenth by the clergy meant, not that proportion of the real value of their income, but a fixed sum, the tenth part of their revenue as assessed in 1291. No provision was made, even in later years, for any increase of this total to correspond to the growing wealth of the church. If, however, a church lost a part of its income through fire. flood, war or other disaster, it might have its assessment lowered. Such was the case with the northern dioceses after the inroads of the Scots during the reign of Edward II had devastated that district. By such means the value of the grants made by the clergy gradually decreased and the assessment of 1291, was to that extent modified.

This settlement was accepted by the clergy of England and when parliament granted taxes upon the laity in 1294, 1295 and 1296 the first

[2] Printed by the Record Commission in 1802.

estate offered separate grants for their order, based upon the Taxatio.[1] Those who did not join with them were to have their personal property taxed with that of the laymen. After the year 1297, when occurred the famous struggle with Pope Boniface VIII over the right of the king to demand taxes from the church, the central government had no further difficulty on this score. The custom thereafter was for the clergy, either in parliament or in convocation, to grant all levies upon their own order, these taxes being collected by ecclesiastics. The individual protestors, met with in large numbers in 1297, thereafter became of no moment.

Very soon a new difficulty, and a very obvious one, arose. As the years passed the church continued to accumulate wealth, through the gifts of pious donors, but, as has been mentioned, no provision was made in the Taxatio for the taxation of such new sources of income. Unless some new plan was introduced this property would wholly escape taxation, or, by being included in that which paid to the clerical grants, would lower the rate of such levies. As the church was the most wealthy of all corporations in England such a result would seem manifestly unfair. The solution of the problem during the reign of Edward I was extremely simple. In the royal instructions to the collectors of the parliamentary subsidy of the year 1297, a tax upon personal property, they are told that, "this taxation shall be made upon the goods of the clergy as upon those of the laity, the which goods are not annexed to their churches."[2] This phrase meant that the clergy were to pay to the lay subsidy for all personal property on lands acquired since 1291, which lands would not be taxed under the clerical grants. Those temporalities included in the taxation of Pope Nicholas were thereafter known as being "annexed to their spiritualities," or "annexed to their churches," the former being the most common form. This principle persisted throughout the reigns of Edward I and Edward II.[3]

The practice used in the collection of the lay taxes during the reigns

[1] *Rotuli Parliamentorum*, Vol. I, p. 227; VINCENT, *Lancashire Lay Subsidies*, Vol. I, p. 189; *ibid.*, Vol. I, p. 192.

[2] *Rot. Parl.*, Vol. I, p. 240 *b*.

[3] The phrase in 1306 is slightly different, the clergy being taxed for their lay fiefs, "lai fe," though so far as I have been able to discover there was no change in practice. *Rot. Parl.*, Vol. I, p. 270 *a*.

mentioned shows that this principle was carried strictly into effect. On all the taxation rolls of the reign of Edward II, which have been examined, there are the names of numerous ecclesiastics paying lay taxes for their personal property.[1] On the close rolls of the same period are also to be found the records of disputes as to the liability of the clergy to be assessed for such taxes for the personal property upon their lands.[2] The point in controversy in these cases is whether the property in question had been acquired before or after the twentieth year of Edward I. If the lands had been acquired after that date the clergy had to pay lay taxes for any personal property they might happen to possess upon those lands. In the Public Record Office there is an interesting little parchment roll recording the taxation of the manor of Eastbrandenham, belonging to the priory of St. Edmund, which clearly indicates this practice with respect to the clergy.[3] It notes the sums which the head of the manor was assessed for the various lay subsidies from 3 Edward II to 25 Edward III, with the names of those who paid these taxes. Though it was owned by the priory, Julian de Stirston who held it, paid in 1307, twenty-nine shillings and three-fourths of a penny to the subsidy of that year. As he farmed the manor, his was the personal property assessed. In 1313 the prior was charged in person with an assessment of twenty-seven shillings and ninepence. Evidently then, the priory had resumed the farming of the manor and possessed taxable personal property within its boundaries. For the remaining years of the reign of Edward II and also during the early part of that of Edward III, either the prior or the cellarer of St. Edmund paid to the lay subsidies assessed upon the kingdom.

With the advent of the next king, Edward III, in 1327, the clause relating to the taxation of the personal property of the clergy, upon their lands not assessed in the Taxatio, disappears from the instructions sent out to the collectors of the lay subsidies.[4] It does not reappear until the reign of Richard II, though at that time in a slightly different form.

[1] E. g., *Cambridge Gild Records*, edited by M. Bateson, pp. 151 *et seq.*; Exchequer Lay Subsidy, 107/10, m. 1, where the names of certain ecclesiastics are stricken out because their [goods] were taxed among the spiritualities."

[2] E. g., *Calendar Close Rolls*, *1307–13*, p. 17; *ibid.*, p. 179; *C. C. R.*, *1313–18*, p. 158; *C. C. R.*, *1318–23*, pp. 647–48.

[3] Exchequer Lay Subsidy, 149/6.

[4] *Rot. Parl.*, Vol. II, p. 426 *b*.

It is, therefore, an interesting problem to account for the taxation of the movable property of the clergy upon lands not valued in 1291, during this intervening period. As the church continued to acquire lands during Edward's reign, the interest is not simply in a past difficulty.

Those records of the reign of Edward III, which have been examined, show clearly, that in spite of the absence of any definite directions to the collectors of the lay subsidies, the practice of the previous reigns continued in force. The evidence of such a condition of affairs is found on all sides, in such rolls of the lay taxes as remain to us, in the manorial accounts and the records of the officials of the ecclesiastical corporations, and more abundantly in the various enrolments of royal and other letters.

There are extant for the first two lay taxes of the reign of Edward III a large number of rolls giving the names of all those who paid to these subsidies.[1] A careful examination of these reveals the names of a number of ecclesiastics paying their share of these purely lay taxes. In many cases the fact that lands owned by the clergy are included on these lists is, doubtless, not to be discovered because of the fact that bailiffs or others were acting as their agents in the farming of these lands. In this case the bailiff's name alone might appear. After the year 1332 the rolls of the names of those who paid to the lay subsidies were no longer made up and it is necessary to rely upon other sources of information. The account already noted for the priory of St. Edmund covers the succeeding period down to the twenty-fifth year of Edward III, showing in this individual case, at least, a continuity of practice. The remarkable series of bailiffs' accounts preserved in the archives of Merton College, Oxford, however, cover the whole of Edward's reign.[2] In the case of

[1] *North Riding Record Society*, new series, Vol. IV, pp. 153, 155, 160, 161, etc.; *Associated Archit. Societies*, Reports and Papers, "Earliest Leicestershire Lay Subsidy Roll, 1327," ed. W. G. D. Fletcher, Vol. XX, pp. 16, 53, 85, 99, 100, 101, 124, 125, 130, 154, etc.; *William Salt Archæol. Society*, Vol. X, pp. 83, 105, 108, 110, etc. An examination of the manuscript rolls gives the same results. For example, the Cambridge roll of 1334, Exchequer Lay Subsidy, 81/10; for Kent, Exchequer Lay Subsidy, 149/9, m. 76 *et passim*. With the latter compare Pipe Roll, number 180 m. 3 d.

[2] They are partially summarized by Thorold Rogers, in his *Agriculture and Prices*, Vol. II, pp 560–65. Owing to the brevity of his account I have checked up his figures in some cases. The entries run somewhat as follows: In the account of the bailiff of the manor of Cheddington, 6–7 Edward III, under expenses there is the following: "Item in expenses taxatorum XV^{e}, II s. II d. Item in dono eisdem III s. III. d. Item solut' taxatorum XV^{e} pro manerio de Chetyndon XVIII s. II. d. ob.'" Merton College MSS. 5564 (Manoria Records).

these manors farmed by the college through its bailiffs, there is noted the payment of all kinds of lay taxes, taxes upon personal property, and taxes upon wool, among others. In this case again the persistence in practice is shown, for the colleges had to gain licenses to acquire land in mortmain and were regarded as ecclesiastical corporations. Certain of the account rolls of the monastic houses contain occasional references to the payment by the official representatives of these houses of the same sort of taxes, evidently for lands acquired after 1291.[1]

The most fruitful sources of information are, however, the various rolls upon which the royal writs are registered, the records of the letters patent and close that were sent out into the kingdom. In the year 1327, the first in which the old clause with respect to the clergy was omitted, the Abbot of Ramsey complained that his temporalities annexed to his spiritualities were being taxed by the collectors of the lay subsidy granted in parliament, although he was accustomed to pay only clerical tenths for the same. A royal letter was immediately issued commanding the collectors to put a stop to such action.[2] An excellent commentary upon the continuance of the older practice is the statement annexed to the grant of the clergy in convocation during the same year, that their tenth was to be levied "of their ecclesiastical goods and of their temporalities annexed to their spiritualities."[3]

During the years that follow the rolls contain many settlements of the status of the lands of the clergy and decisions of disputes as to whether the land was acquired before or after the twentieth year of Edward I.[4] In 1341 and the following years there is an especially long list of exemplifications or statements of the goods of the ecclesiastical

[1] *Accounts of the Obedientiars of Abingdon Abbey*, *Camden Society*, Vol. CXXXVI, p. 8: "Expense apud Drayton. In XV^{e} Domini Regis VIII s. IX d."; Chronicon *Abbatiae Rameseiensis* (Rolls Series), appendix, 353, payments for the wool subsidy.

[2] *Cartularium Monasterii de Rameseia* (Rolls Series), Vol. III, p. 31. In the accounts of the collectors of the subsidy, printed on pages 30–31 of the above work, it is noted that the goods of the abbot were excused because of this writ from the king.

[3] *Letters from the Northern Registers* (Rolls Series), p. 349.

[4] K. R. Memoranda Roll, No. 111 (10 Edward III), m. 27; The prioress of Elnestowe claims that the collectors of the 15th are attempting to tax the goods of the priory although all its lands are temporalities annexed to spiritualities. *Ibid.*, m. 27*d*, a similar complaint by the abbot of Wouburn. In the patent rolls we have an inspeximus of the temporalities of the abbot which are taxed in the clerical tenth, *C. P. R.*, *1334–38*, pp. 492–93. *Ibid.*, m. 174, where the Prior of St. John of Jerusalem in England claims that all of the goods of the order have always been taxed with the laity. Cf. *Rot. Parl.*, Vol. II, p. 98; K. R. Mem. Roll, No. 110, m. 134*d*, 185*d*; *C. C. R.*, *1339–41*, pp. 430, 485, etc.

corporations which were taxed when tenths were granted by the clergy.[1] These writs were issued for the protection of these bodies from the assessors and collectors of the ninth, a new form of tax from which the clergy evidently thought that they had something to fear. The last statement is borne out by their petition to the crown in the parliament of 1341, in which they pray for a just statement of their position under the ninth.[2] In his answer to the petition the king simply states the existing practice as it is known with respect to other taxes, that, if the clergy have temporal possessions not taxed under the clerical tenths, they should pay the ninth upon them, so that for goods for which they pay under the one tax they will not have to pay under the other.[3] It is perfectly clear why the exemplifications were so eagerly sought from the king at this time, and why the clergy who wrote the chronicles raised no outcry against this settlement. If there had been anything new in this inclusion of certain of the temporal goods of the ecclesiastics within the property taxable by parliament there would surely have been much complaint against royal oppression. In after-years there are to be found occasional exemplifications of a like nature and other references to the liability of the clergy to be taxed with the laity for personal property upon a part of their landed possessions.[4]

When the next new type of lay taxation, the parish tax of 1371, was to be levied according to the revised rating of 116 shillings to the parish, it is noted on the rolls of parliament and also in the writs to the collectors, that the county of Chester and the lands and possessions of Holy Church, acquired before 20 Edward I, and taxed in the tenth, were to be excepted from this levy.[5] As Chester never contributed to the

[1] E. g., *Calendar Patent Rolls, 1340–43*, pp. 300, 343, 350, 371, 376–7, 421, 469, 520, etc.

[2] *Rot. Parl.*, Vol. II, p. 129.

[3] *Rot. Parl.*, Vol. II, p. 130 *a*. In the year book for the year 1343 there is an interesting case, in which the prior of Huntingdon is involved, which serves as a commentary upon this taxation. *Year Book* 17 *Edward III* (Rolls Series), pp. 598–603. See also *Calendar Patent Rolls, 1343–45*, p. 565.

[4] *Calendar Patent Rolls, 1343–45*, pp. 260, 565; *Memorials of Ripon*, Surtees Society, Vol. I, pp. 240–41, where after an inquisition it is found that a hospital is not and has not been charged with lay taxes; Rogers, *Agriculture and Prices*, Vol. II, p. 669; a petition of the scholars of Merton College to be freed from all lay taxes; cf., *ibid.*, 155, 156; Rot. Pat., 21 Edward III, Part I, m. 3*d*, an inquisition as to the lands held in Cambridge by the religious acquired since 20 Edward I, and as to what they paid to the king's taxes. In Kent there are several references upon the rolls to the payment by the clergy of lay taxes, Exchequer Lay Subsidies, 123/20, 123/27.

[5] *Rot. Parl.*, Vol. II. p. 304; Fine Roll, No. 172 (45 Edward III), m. 22. Cf. Stubbs, *Constitutional History of England* (ed. 1896), Vol. II, p. 443.

national taxes of the reign of Edward III, and as the temporalities annexed to the spiritualities were never taxed under grants made by the laity in parliament, this is merely a plain statement of the existing practice on the negative side.[1] Only a few years later, in the first parliament of the reign of Richard II, that of 1377, the commons petitioned and the king granted that the clergy should contribute their share, when lay taxes were levied, for goods upon all their possessions acquired since 20 Edward I.[2] In the writs sent to the collectors of the tenth and fifteenth of that year a clause was added to that effect.[3] The silence ot the chroniclers upon this move is the best kind of evidence that it was nothing new and in no way considered oppressive. If the action of the council then ruling the kingdom had been to introduce a plan of taxation that would reach church property hitherto untouched, one might well imagine the indignation of all pious churchmen throughout the realm of England.

There remains to be considered in connection with this subject the curious answer made by King Edward III to the petition of the commons in parliament in the year 1346.[4] The commons prayed that the abbots, priors and other religious, who had purchased lands or tenements since the twentieth year of Edward I, should be charged and taxed for the same with the men of the community; and in order to raise these taxes that it be possible to distrain all of their lands for which they did not pay clerical tenths. Thus far the matter is quite clear. It is quite possible that the commons feared that the religious houses might be able to escape taxation either by claiming that their lands were acquired before the year mentioned, or in some other fashion, and, on that account, desired an authoritative royal answer upon the subject. The reply of the king is not so clear. The first part accords with the existing practice as it is known: "As for this point, it appears to the council, that the religious who pay their tenths with the clergy,

[1] A statement of such a nature hardly warrants the remark of Stubbs, *op. cit.*, Vol. II, p. 443, that the chancellor reported that "all the church lands acquired since 1292 must be included among the contributors."

[2] *Rot. Parl.*, Vol. III, p. 24 *b*.

[3] Fine Roll, No. 179 (1 Richard II, Part I), m. 5. The clause reads: "necnon de viris ecclesiasticis de bonis de terris et tenementis suis post annum vicesimam dominum E. fil' Regis Henrici progenitoris nostri adquisitis."

[4] *Rot. Parl.*, Vol. II, p. 163 *a*. Cf. Stubbs, *op. cit.*, Vol. II, p. 416.

and were accustomed so to pay before the said twentieth year, should be discharged of fifteenths for the possessions upon which they pay the tenths." The fifteenths were lay taxes, the tenths, in this instance, clerical. The following clause reads: "And for the lands upon which they pay no tenths, they should be charged with the tenths *come assiert.*" This neither conforms to the existing practice nor answers the petition of the commons. Unless we read fifteenths for tenths in the second part of the last clause it is, seemingly, a mere absurdity or an exceedingly evasive answer.

All the evidence that has been collected upon this subject bears out the conclusion that there was regularly laid upon the clergy of England, for their personal goods upon lands acquired since the twentieth year of King Edward I, the burden of sharing with the laity the national taxes granted in parliament. So far as this portion of their property was concerned, no distinction can be made between them and the mass of the laymen of the kingdom. When we read the complaints of men like Wycliffe and the commoners of the later fourteenth century, against the wealth of the church and its insufficient taxation, we must, therefore, look for the background of these attacks in other spheres of activity. That there must have been some reason, and some good reason, for these attacks, must be granted, but it is difficult to see, on this side at least, how the clergy could have been expected to pay more than the laity when parliamentary subsidies were levied.

SHAKESPEARE AND PSYCHOGNOSIS

ESSAY IV. TYPES OF SITUATION IN "THE TEMPEST"

By Melanchthon F. Libby

In the foregoing essays on types of character, however objective exegesis may have erred, it has been impossible to miss the general determination of types, because they are definitely fixed by the author in the *Dramatis Personae.*

We now pass to a more hazardous attempt, and one in which error is impossible to be avoided, even in the selection of the types themselves, to say nothing of their significance.

As in the previous parts, I have drawn upon all available criticisms, and have found them all more or less helpful, however narrow and fragmentary. One is inclined to say of *The Tempest,* as someone has said of philosophy, that all the different views which have been expressed (perhaps some others also) would, if hammered into a consistent whole, give a true account of the matter.

I have arbitrarily selected thirty types of situation which occur in *The Tempest,* and which seem to me to offer headings for a companion study to the thirteen types of character. I have chosen these types of situation because they seem to me to represent in a more or less striking manner all the most important relations of the individual types to the social environment. And here I must make a confession which will disappoint any reader who may have rashly connected this effort at objective criticism with any counsel of perfection based upon the ways of physics and chemistry, or of Professor Pearson's *Grammar of Science;* and that is, that I do not clearly know what a type, in the sense in which I am employing the word, precisely means. A type no doubt should embody the characters of its group in some striking manner. Emerson clearly means his *Representative Men* to be types of important human groups, but he selects them in an arbitrary, though exceedingly instructive manner, and gives us no account of his ground of choice, which is indeed perhaps an unanalyzed interest in his own experience. Everyone will agree that the *philosopher*, the *mystic*, the *skeptic*, the *poet*, the *man of the world*, and the *writer*, are immensely significant types. But contrast these with the group in *The Tempest*, and one feels that a general and proportioned chart of psychognosis is the last thing in Emerson's mind. Then, again, are men like Plato, Swedenborg, Montaigne, Shakespeare, Napoleon, and Goethe, really *types* at all, or are they quite unique and exceptional men who reject the characters of all groups, not least of their own special groups, to be themselves? And yet this also is unsatisfactory, because manifestly each does represent a very large group distributed about an average, as all groups are, whose purposes and aspirations, qualities and defects, are quite clear only in the light of these victorious examples. The doctrine that a type represents an average example of a group certainly seems to fail when applied to literature; for, however intent a poet or novelist may be in making a generalized example of a group, it is in the very nature of art to intensify and heighten the qualities represented. Then again, art is above all selective. A "bad memory" is a special need of the artist, and this is true even of the realist. In creating ideal types all those characters of a type which are irrelevant to its representative quality are omitted.

Antonio represents intellectual egoism, yet he is far more able, intense, cruel, and selfish than the average egoist; indeed, in history, we find only a few who approach him in emphasis. In dealing with types of situation we should find the same truth. The situations are extreme rather than average types. But their supreme value is in their general proportions, the truth of the whole set of them to the whole-world picture. I agree with those who hold that enlightened men of our day have little to learn from Shakespeare concerning particular cases of human psychology; his peculiar gift to us is not his modern and specialized, but his classical and proportioned, quality. Ibsen can describe Peer Gynt; Tolstoi, Anna Karenina; but none of these recent geniuses can offer us a proportioned valuation of life.

But even Shakespeare seldom endeavors to give us a complete poetic *Weltanschauung*. When he tells a tale of jealousy, the types are selected with reference to that important, but still quite narrow, phase of human interest. In the *Midsummer Night's Dream* he did perhaps aim at molding and fashioning the whole lump of clay, but that was an unsophisticated effort.

What we can say of the types of *The Tempest* is that they are his final and thoroughly experienced and sophisticated effort at a complete *Weltanschauung*, in which no single, however great, human interest, but the whole human interest, call it what you will, *life*, *society*, *ethics*, *psychology*, *philosophy*, *nature*, *history*, *wisdom*, *psychognosis*, is the subject more or less consciously portrayed in his concrete dramatic method of expression. Personally I believe that in this period the dramatist was pretty conscious of the philosophic quality of his work; but I do not think this can be proved, and it is hardly in the interest of art, as we find it, to attempt such proof. The difference between this play, however, and such work as Plato's *Republic* or the *Nichomachean Ethics* seems to me to be not so great as regards method and attitude as the difference between earlier plays of Shakespeare's and these abstract writings, though I also believe that Shakespeare was a good deal of a philosopher even when he wrote the *Comedy of Errors*.

1. The Ruin *Motif*.—In the exposition of the types of character, all these types of situation have necessarily been discussed in detail, though indirectly; accordingly it will fortunately be unnecessary to follow the tedious method that has seemed necessary heretofore.

The shipwreck scene seems to me to be even superior to the celebrated first scene of *Macbeth* as a keynote of its play. It is a type of all situations which test and try the human soul, and make all masquerading and shuffling impossible. "In the reproof of fortune lies the true proof of men." The shipwreck takes on a symbolic significance, which is one of the trite metaphors of all literature. We have read of the "ship of state" (cf. Gray's *Bard*), and moral writings constantly employ such similitudes as *haven*, *harbor*, *storm*, *course*, *breakers*, *full sail*. *Shipwreck of fortune* is a common phrase. In private life, the scene suggests bankruptcy, "loss of grip" in a profession, disaster to reputation, scandal and disgrace, as in the story of *Faust*—any of the grand catastrophes or failures that suggest despair and suicide even to the strong and innocent; in national life, overwhelming defeats in war, such as the collapse of France in 1870; the loss of commerce, such as ruined the Italian cities;

the downfall of great causes, such as reduced to prostration the southern states in 1865; the wiping out of cities by fire or earthquake; the devastation of pestilence, such as that of England by the Black Plague in the fourteenth century. These examples will suggest enough to establish the typical quality of the scene, and the great men in private and national life who, like the heroes of the city of Chicago, or the statesmen of the French Republic, or Heine struggling with disease, have kept their minds above fate and have met difficulties with courage, will be seen to correspond to the better characters of the scene. The best *Weltanschauung* may not represent the life of man as a tempest, but it begins by so representing it. That is the keynote. The world is full of peril; wisdom is not in easy-going optimism; pedagogy should train children to expect battle, and to accustom themselves to struggle and to sleep on the field of battle. If the piping times of peace should actually make up the greater part of the play, yet it is because of the courage and the protection of those who would bear themselves best in storm and stress. Peace is a positive not a negative state, "for the rain it raineth every day."

2. The Cain *Motif*.—Those simple critics who find fault with Shakespeare for not inventing his own stories, forgetting the words of Horace, and the practice of Vergil, the multiplicity of Madonnas, and the gifts of Wilkie Collins and Conan Doyle, cannot indeed find fault with the *plot* of *The Tempest*, which seems to be very much the poet's own, but they should revel in the triteness of the *situations* of that plot which are literally as old as the hills. The dramatist would seem to have made the plot purely that he might be free to give shape and proportion to the very platitudes of story-telling with greater freedom. Proportion or a set of right values is the very philosophy of art, and the lack of it chaos and failure. If there is any one supreme lesson of really great and classical work, it is that sanity and proportion are synonymous. False emphasis, eccentric valuations, perverse originality of type, are no doubt useful, and at times pleasing or interesting, notes in the whole great orchestra of art; but the classic works eschew all these, and give us that perennial truth and beauty which works not created with one eye on the whole of life can never possess, and for lack of which they narrow, dwindle, and drop out.

I have named the situation in which Antonio hates and would murder his brother the Cain *motif*, in order to emphasize its classical, rather than its inventive, merit. The sun rises every morning, and the night comes on after sunset; but sunlight and spring and youth and night and winter and death are never called trite or stale or platitudinous. When the right genius comes to his own, these are still the supreme notes in literature, but, as the *Ars Poetica* has so well said, let no third-rater attempt the tale of Troy. What greater platitude than *Crossing the Bar*, but who thinks of that, or asks for originality? It is when Tupper writes of death that we yawn.

It was Samuel Johnson himself who found this Cain story of Antonio tedious. And who will say it is not so, if we once lose hold upon the whole tragi-comedy as a mythology of human nature? But once become seized of the idea that Shakespeare is charting the world of men, drawing with a sure hand of a Greek architect the whole parallelogram of human social forces, and the more common the type, the more eager the reader. It is some similar reflection that finally makes Milton's great syntagma of names seem suddenly, not arid pedantry, but a glorious illumination of history. Our tediousness comes, not from the great poets, but from ourselves.

It would be a work of supererogation to suggest the broad typical value of the Cain *motif*, and it is no part of our purpose to trace the legend genetically. What Antonio is in human character the Cain *motif* is in human environment. The deadly animosities of social, professional, and family life; the ruinous hatred of commercial, municipal, and political life; the unscrupulous wars between nations for purposes of aggrandizement, vanity, and lust of conquest, make a great part of every biography and history obscure or famous. Wherever the bonds of sympathy or justice have snapped we find the story of Cain repeated.

3. The Exile *Motif*.—The art of this most Greek of Gothic dramas is so repressed that the pathos of the exile of Prospero might easily be missed. In the story of Dante we may read this phase of Prospero. The loneliness of idealists has been sung over and over in modern romantic writing—by Coleridge in the *Ancient Mariner*, by Byron in the *Childe Harold*, by Emerson; indeed, by nearly every poet of modern

times. But, as Theodore Vischer has said, Shakespeare is not inclined to this kind of self-pitying tenderness; even at his finest and gentlest he is strong and robust. In this play there is no desire to appeal to any but the largest, strongest emotions. And yet, when these by prolonged reading are discovered to be repressed and implied, they break upon us with tenfold force.

What sorrows of Werther, or of the *In Memoriam*, or of any modern pathetic writing, are comparable to the sorrows of Prospero? All losses have been his. His kingdom is lost; his wife is dead; his loneliness, materially, intellectually, socially, are complete; his sensitiveness and imagination are infinite. His love and desire for love can be measured by his labors for others, his persistent obstinacy in a hopelessly unworldly ambition, his actual sacrifice of all that others put first. Only the greatest have been wanderers in exile in the entire sense of this situation; but how many of these? This is the situation of all who are misunderstood in the sincere sense of the phrase. And the group concerned is not made up only of the most gifted, but of all who in fainter colors resemble them.

4. The Power *Motif*.—There is a striking likeness between the aims of Prospero and the aims of Bacon. The *New Atlantis* might have been suggested by the island and cell of Prospero. Bacon would restore and multiply the power which the Greek world had achieved by an increase of real knowledge—the knowledge that is workable, and that controls and eliminates chance and superstition. Prospero had lost his kingdom, famed for the liberal arts; he regains it by a study of natural forces. His very name suggests Bacon's favorite dream. If there is too much of the supernatural element in the island, this is owing to the poetic fancy of Shakespeare; and it must not be forgotten that Bacon was far from emancipated from similar ideas even in his most scientific works. Modern science freed itself very gradually from the penchant for magic; indeed, is not entirely free yet, as the teleological remarks in our textbooks, and the belief in spiritualism, testify. And, then, is there not more of the marvelous in valid science than we need to justify the feats of Prospero? Would not the dramatic strokes of Marconi and Röntgen and others have been too great a tax on the imagi-

nation even of the Elizabethans? Prospero makes his will his act immediately—that is, through no recognizable means or processes, the spirits come and go like thought itself, untrammeled by material spatial or temporal obstacles; yet how near to all this has the control of electrical energy brought us in fact! This *motif*, like most of them, recurs frequently throughout the play.

It is the type of all those situations in which learning is addressed as the truest thread through the labyrinth of life. Above all, it is the education-philosophy, the science solution, the trust in right reason and the reign of law, the *amor intellectualis Dei*, the faith that *laborare est orare*, that the gods will never do what they have enabled us to do.

It appeals to the workers in universities and all schools, and to those solitary but benevolent recluses who pursue their own lonely and laborious researches, and who neither fear nor love anything in the universe but the very truth, and the justice and well-being it confers. Its heroes include Thales and Pythagoras and Empedocles, Democritus, Aristotle, and Lucretius; bute qually Parmenides, Anaxagoras and Plato, Phidias, Pericles, Sophocles, and Cicero; Augustine, Thomas, Duns Scotus, Dante, the martyred Bruno and Campanella; and every great man in philosophy, science, art, religion, education, statesmanship, literature—all who know the meaning of the *Grammarian's Funeral;* all who have led toward law, reason, justice and enlightened liberty.

All who love and strive for power are dear to Shakespeare. Even the tyrant and murderer come within the range of his godlike breadth and sympathy, provided that they sacrifice all and die with their harness on their backs in the quest for any element of the ideal commonwealth. Is not this the explanation of his tenderness for the blood-stained Macbeth, and of our unconquerable affection for the "vulgar adventurer" (as Green calls him) Napoleon? The worship of weakness does not appeal (except as a means) to the race nor to Shakespeare.

In this fascinating portrayal of power, learning, control, natural morality, justice, reason, and prosperity, Shakespeare has indicated the very axis of his maturest *Weltanschauung;* all else, even altruistic idealism, is subordinate, temporary, pedagogical, a necessary means, to this great end.

5. The Fatigue *Motif.*—But alas!

> The boast of heraldry, the pomp of power,
> And all that beauty, all that wealth e'er gave,
> Await alike the inevitable hour,
> The paths of glory lead but to the grave.

What are all the reason and learning of the world to the wretch entangled in those tortures from which no science can release him?

"Through forthrights and meanders," groans the weak but well-meaning Gonzalo, "I needs must rest me." He is weary and heavy-laden. And Newman echoes this sentiment and finds a wide response: "O'er moor and fen, o'er crag and torrent, till the night be gone." Also other weary and high-aspiring souls, such as Arnold in the beautiful *Rugby Chapel:*

> With frowning foreheads, with lips
> Sternly compressed, we strain on.

This *motif* leads to the highest flights of altruistic idealism. Take down the hymnbook of any church, and read the lyrics of the weary and heavy-laden; they all end in flights of angels and the joys of Eden. This is one of the most significant truths of psychognosis. Take down Haeckel's *Wonders of Life*, and certain bills presented to American state legislatures, and they advise us to destroy the weak and incurable. What does all this signify but a general confession of weakness? If the egotists who claim to be strong and to monopolize reason were really strong and possessed of the law of nature, they would have no excuse.

It would be useless to argue the value, as a typical situation, of the fatigue *motif.* All the loftiest and sweetest thoughts of the race have come from, or been inspired by, the misery and degeneracy of those who are crushed in the great transition from animal to spiritual power. All the tragic love-stories of the world—the love of Socrates for truth, of Jesus for democratic equality, of Dante for Beatrice—are echoes, or brave representations, of the world-weariness of the evolutionary army, forced in loyalty to act upon the orders of the day, yearning inwardly for the order of a perfect time. All ideals are sown in weakness, pain, disease, degeneracy, fanaticism, madness; and without this fertilization is no possible raising in learning, control, reason and power. It is

Rachel weeping for her children, the king crying "My son, my son," who urge on the *New Atlantis*, realize *Utopia*, found universities.

6. The *Motif* of Genius in Service.—The relation of Ariel to Prospero is a symbol of the relation of geniuses, of the advanced and enlightened, to the general welfare of society. For example, is a great artist to be regarded as quite above the ordinary laws and standards of his environment—a law unto himself, a superman or *Uebermensch*, free to work or play, free to paint any and everything that pleases his imagination, free to disregard the humdrum virtues and aspirations of the dreary commonplace hordes of the Philistines? Is art its own end, and truest to itself when it bloweth where it listeth? Certainly, to oppose this view is to incur the disdain of many a fiery imagination which sees in this heresy nothing but defective vision, utterly prosaic, incompetent to judge what is not really comprehended. Read the claims of *Zarathustra*, or of Max Stirner, and of their many disciples; some, sincere and able; most, frothy and weakly. Of course, the artist is only an example. Imagination and power, as Ribot has so brilliantly shown, are not confined to art, but are found equally, or even in greater intensity, in war and statesmanship, in science and philosophy, in invention and engineering. There is a fountain of growth and playfulness in men and women of genius which keeps them exposed to the caprices of adolescence, and prevents them from settling in stable habits, often during the whole period of life. Are we to regard this as a justification of lawlessness, or merely, in the old-fashioned way, as a palliation or excuse.

On closer reflection the problem seems well-nigh insoluble. It must never be forgotten by the moralist that the poet—that is, the man or woman of imagination, the *maker*—was born "in a golden clime."

The poet has proven a thousand times that he knows more than the common-sense of the race believes. Poetry is closely analogous to faith. It is the nature of poetry to make dreams which time turns to commonplace realities. By poetry Copernicus recreated the heavens for us; by poetry Columbus failed to reach India and landed at San Salvador; by poetry Röntgen saw through opaque coverings; by poetry Hampden and Mirabeau and Jefferson brought liberty and democracy back to earth. How dare we then put habit, even good habit, even the best habit, above originality? Is not every evolutionist bound to revere the law-breaker, the rebel, the freaks, cranks, radicals, if only as variants, as "sports," as sporadic instances of possibly greater types than any that have been? We would lay down the law to the poet—tell him what to eat, drink, wear, do, think, feel; but he has been before us in every path.

> He saw thro' life and death, thro' good and ill,
> He saw thro' his own soul;
> The marvel of the everlasting will,
> An open scroll,
> Before him lay.
>
> . . . .
>
> And Freedom reared in that august Sunrise
> Her beautiful bold brow,
> When rites and forms before his burning eyes
> Melted like snow.

Truly one poor poet's scroll may shake the world—has shaken the world, over and over again. "As sure as the sun rises," says Common-Sense. "The sun stands still while the earth rotates," retorts Genius. "As certain as chalk is chalk, or cheese is cheese," says Common-Sense. "Chalk and cheese are groups of vortices in ether, or electric tensions, or perhaps dreams of will," says Genius. "Away with such monstrosities," says Common-Sense; "burn these men, crucify them, tear them limb from limb." And Genius answers, either with martyrdom or with a joke, but always with pity and contempt for our blindness: "You cannot burn the truth."

What is the conclusion of the whole matter? Common-Sense cannot tell whether any new departure is for better or for worse. In every age Genius has made departures from accepted standards of reason, faith, beauty. Nearly all these departures are condemned by results. But "the many fail, the one succeeds." One genius in many has found the right direction of progress; the army breaks camp, often after murdering the successful scout, and strikes a fresh claim into the unknown.

Is Ariel really the imaginative type in Shakespeare's *Weltanschauung*? He seems to do always the right thing, to be in harmony with the reign of law. But his rebellious attitude, his moodiness, his desire for freedom *outside* of the social nexus, show that his wisdom comes from the clear science of Prospero. It is only when the inspiration of genius is controlled by the insight of science and the test of law—that is, only when fancy is controlled by the wisdom of experience, and the requirement of *workability* that it ceases to beat its wings ineffectually in the void, and *becomes* a function of progress.

[*To be continued*]

THE BEES OF BOULDER COUNTY, COLORADO

By T. D. A. Cockerell

The bee-fauna of Boulder County has proved remarkably rich and interesting, yielding a considerable percentage of new species. It is, of course, very far from being exhausted, but the following tables are offered as a means of facilitating further progress. Various species, especially of the genus *Halictus*, are for the present omitted, as they cannot be identified until our studies of the genera they belong to have progressed further. Many species of *Halictus*, *Osmia*, and *Andrena* have been sent to Messrs. Crawford, Titus and Viereck respectively for investigation, but nothing has been learned concerning them. They will doubtless be discussed in forthcoming works by these apidologists.

The list, as it stands, numbers about 175 species. In the vicinity of Carlinville, Illinois, Robertson appears to have found about 275, after years of careful collecting. Owing to the varied conditions represented in Boulder County, it is not unlikely that the total number of species existing considerably exceeds 300. I have inserted in the tables a number of species likely to occur with us, but not yet actually found. These are distinguished by an asterisk. At some later date, I may offer a discussion of the families and genera of bees; but this does not seem very necessary at present, owing to the existence of several works covering the ground, more especially those of Robertson and Ashmead (*Trans. Amer. Entom. Society*, 1899; *Canadian Entomologist*, Feb., 1904, etc.). Cresson's *Synopsis* (1887), though old, is still very useful for determining the genera.

COLLETES Latreille

Comparatively large (length of anterior wing about 8 mm.), hair of thorax above fox-red, especially bright on scutellum, without any black intermixed (Boulder, fls. *Heuchera*) . . . . **andrewsi** Ckll. (**simulans**, Cress., in part)♀

Not so large; hair of thorax above not thus bright . . . . 1.

1. Hair of head and pleura black (Ward, July, fls. *Drymocallis*) . **nigrifrons** Titus

Hair of head and pleura light. . . . . 2.

2. Some dark hair on thorax above, at least on scutellum . . . . . 3.

No dark hair on thorax above . . . . 4.

3. Larger, antennæ of male long, the joints of flagellum much longer than broad (Boulder Canyon, June) . . . . **hydrophilus** Ckll.♂
Smaller antennæ of male much shorter, the joints of the flagellum short; punctures of abdomen very strong (Boulder, fls. *Campanula*) . . . .
brevicornis Rob., form **opuntiæ** Ckll.
4. Comparatively large and robust, with the hair of the thorax above yellowish or ochraceous; second submarginal cell very broad (Ward, July, fls. *Frasera*).
kincaidii Ckll.
Smaller, with the hair pallid . . . . 5.
5. Female; hair very pale, the abdomen with broad feltlike white apical hair-bands, and white hair on basal part of segments; malar space twice as broad as long (Ward, July, fls. *Phacelia*). . . . . **phaceliæ** Ckll.
Males, with long antennæ; hair of face white (male *kincaidii*, if run to here, is separated by ochreous hair of face) . . . . 6.
Males, with antennæ of the short type . . . . 7.
6. Larger; hair of head and thorax yellowish-white (Florissant) . **sieverti** Ckll.*
Smaller; hair of head and thorax clear white (Boulder) . **salicicola geranii** Ckll.
7. Larger; hair of thorax above a little yellowish (Florissant) . **florissantia** Ckll.*
Smaller; hair of thorax above not yellowish (Florissant) . . **polemonii** Ckll.*

I had described *C. opuntiæ* as a distinct species, but Mr. Swenk gives good reasons for supposing it only a form of *brevicornis*. He has the latter from as far west as Sioux Co., Nebraska, and Missoula, Montana.

The flowers of *Petalostemon* in eastern Boulder County should be examined, with the hope of finding *C. aberrans* Ckll. and *C. wilmattæ* Ckll. The latter has red legs.

PROSOPIS Fabricius

Face entirely black; size relatively large . . . . **basalis** Smith♀
Face not entirely black . . . . 1.
1. Scape of antennæ heart-shaped, one side light . . . . 2.
Scape not heart-shaped, all dark . . . . 3.
2. Larger; anterior wing over 5 mm. . . . . **basalis** Smith♂
Smaller; anterior wing under 5 mm.; face markings cream-color. (Florissant)
antennata Cress.♂*
3. Females; clypeus entirely dark . . . . 4.
Males; clypeus light . . . . 5.
4. Larger; anterior wing over 4 mm. (Boulder, May 1906, *Grant LeVeque*)
varifrons Cress.
Smaller; anterior wing under 4 mm . . . . **tuertonis** Ckll.
5. Lateral face marks curved above, receding from orbits (Florissant) **tridentula** Ckll.*
Lateral face-marks not curved above, or receding from orbits . . . 6.
6. Upper part of lateral face-marks very broad . . . . . **coloradensis** Ckll.
Upper part of lateral face-marks narrow and pointed (Boulder) **universitatis** Ckll.

P. basalis was found at Ward, at flowers of *Drymocallis* and *Senecio*. In South Boulder Canyon, Aug. 9, 1906, my wife and I took two male *coloradensis* and three female *tuertonis* visiting the same plant of *Solidago*. This would appear to indicate that these are the sexes of one species, but the first abdominal segment is much duller and more conspicuously punctured in *coloradensis* than in *tuertonis*.

SPHECODES Latreille

All ours have the head and thorax black, the abdomen bright chestnut red. The table is based on females.

Small, anterior wing much less than 5 mm.; wings clear; mandibles red (Colorado Springs, etc.) . . . . **eustictus** Ckll.*

Larger, anterior wing slightly or greatly over 5 mm. long . . . . . 1.

1. When the abdomen is viewed from the side, a strong and deep constriction seen between the first and second segments; size comparatively large: wings strongly smoky (Boulder) . . . . **pecosensis** Ckll.

Abdomen without any, or any strong, constriction between first and second segments 2.

2. Larger, anterior wing about 7 mm. long; wings strongly dusky; mandibles bidentate (Boulder, fls. *Pulsatilla*, April) . . . . . . **hesperellus pulsatillæ** Ckll.

Smaller, anterior wing not over 6 mm . . . . 3.

3. Wings practically clear; abdomen entirely red (Boulder) . . . **sophiæ** Ckll.

Wings dusky; apex of abdomen black (Florissant) . . . . **sulcatulus** Ckll.*

PROTERANER Robertson

Similar to *Sphecodes*, but the abdomen is narrow, and the males appear in the spring with the females, which is not the case with other Halictinæ. In Europe there is also a group of *Sphecodes* in which the males appear in the spring; thus the male of *S. rubicundus* v. Hag. has been taken in England in May, the male of *S. majalis* Perez in France in April. I do not possess specimens of these species, and cannot say whether they should be referred to *Proteraner*.

The Colorado species of *Proteraner* are as follows:

Male about 9 mm. long, abdomen dark red, first segment black at base, and with a large black spot on disk, apex broadly rounded (Boulder, Manitou, fls. *Ribes*) **leptanthi** Ckll.

Male about 8 mm.; abdomen narrower and lighter, the basal half of first segment black (Manitou) . . . . **rhois** Ckll.*

HALICTUS Latreille

The table is based on females.

Head and thorax black . . . . 1.

Head and thorax green or blue . . . . 8.

1. Abdomen red (Northern New Mexico, fls. *Castilleia*) . . . . **ovaliceps** Ckll.*

Abdomen black, banded . . . . 2.

2. Hind tibiæ and tarsi clear red; size large; area of metathorax granular (Boulder, fls. *Odostemon* and *Opuntia*) . . . . **lerouxii ruborum** Ckll.

Hind tibiæ and tarsi dark, at most a little reddish, but with light hair . 3.

3. Cheeks broad, with a tooth beneath (Boulder, fls. *Odostemon* and *Senecio*) **armaticeps** Cresson.

Cheeks not toothed beneath . . . . 4.

4. Area of metathorax with strong ridges; abdominal segments with strong white basal bands; wings very clear (Boulder) . . . . **sisymbrii** Ckll.

Area of metathorax granular, or at most with minute feeble ridges or striæ. 5.

5. Large, fully 11 mm. long; abdominal hair-bands on apices of segments; third submarginal cell twice as broad as second (Boulder, fls. *Pulsatilla*; *G. Weston, E. Bethel, T. & W. Ckll.*) . . . . **lerouxii** Lep.
Smaller; hair bands wholly or mainly on bases of abdominal segments 6.
6. Wings clear, almost milky, large for size of insect; stigma amber color (Boulder, April 30, *T. & W. Ckll.*) . . . . **aberrans** Crawford
Wings smoky . . . . 7.
7. Larger; not shining (Boulder, fls. *Salix, Harry House*) . . **trizonatus** Cresson
Smaller; shining (Florissant) . . . . **cooleyi** Crawford *
8. Abdomen broad, the hind margins of the segments with hair-bands; third submarginal cell more than twice as broad as second . . . . 9.
Abdomen not thus banded; third submarginal cell not so large in proportion to second . . . . 10.
9. Larger, abdominal bands very dense; head and thorax brassy-green (Boulder, fls. *Claytonia lanceolata*) . . . . **arapahonum** Ckll.
Smaller, abdominal bands usually less dense; head and thorax blue-green (Boulder, fls. *Phacelia, Claytonia lanceolata*) . . . . **meliloti** Ckll.
10. Abdomen amber-color (Florissant) . . . . **scrophulariæ** Ckll.*
Abdomen black . . . . 11.
Abdomen green or blue . . . . 12.
11. Smaller; area of metathorax with very fine delicate striæ on basal part (Halfway House, Pikes Peak, Sept., *Ckll.*, also Florissant) . . . . **ruidosensis** Ckll.*
Larger; area of metathorax with coarse strong ridges (Gregory Canyon, Apr. 16, fls. *Pulsatilla hirsutissima*) . . . . **cressonii** Robertson
12. Hair of abdomen, covering segments 3 to 5, pale ochraceous (Boulder, fls. *Pulsatilla hirsutissima*, May 1, *Marie Gill*) . . . . **pilosus** Smith, var.
Hair of abdomen white . . . . 13.
13. Head oval, face comparatively narrow (Boulder, fls. *Senecio*, May 17, *W. P. Ckll.*) **pruinosus** Robertson
Head round, face comparatively broad (Boulder, fls. *Odostemon*, April 6, *W. P. Ckll.*) . . . . **pruinosiformis** Crawford

The following table, adapted from Crawford, will facilitate the determination of certain males.

Species without any green . . . . 1.
Species with more or less green; wings and nervures dark . **cressonii** Robertson
1. Face and legs entirely dark . . . . **sisymbrii** Ckll.
Face and legs not entirely dark . . . . 2.
2. Species with hair-bands on the apical margins of abdominal segments . 3.
Species without such hair-bands . . . . 4.
3. Flagellum bright ferruginous beneath . . . . **armaticeps** Cresson
Flagellum darker beneath . . . . **lerouxii** Lep.
4. Tibiæ entirely dark . . . . **trizonatus** Cresson
Tibiæ not entirely dark . . . . **cooleyi** Crawford*

Mr. Crawford informs me that *H. colatus* Vachal, described from Colorado, is a male *trizonatus*.

DIALICTUS Robertson

Like the species of *Halictus* with green or blue head and thorax, but with only two submarginal cells. The table is based on the females.

Tegulæ testaceous (Boulder, fls. *Phacelia*) . . . . . . **anomalus** Robertson

Tegulæ dark . . . . 1.

1. Bluish; abdomen with metallic luster; face narrow (Las Vegas, N. M.) **theodori** Crawford*

Greenish; abdomen without metallic luster; face broader (Boulder, fls. *Drymocallis*) **occidentalis** Crawford

I have not now access to the type of *D. theodori*, but it occurs to me as just possible that it is an aberration of *Halictus semicæruleus.*

AUGOCHLORA Smith

Comparatively large and robust; hind margin of second abdominal segment finely ciliate (Boulder). . . . . **fervida** Smith.

Much smaller, not so robust (Boulder, fls. *Hydrophyllum*, May 18. *Ckll.* S. Boulder Canyon, fls. *Grindelia*, Aug 9, *W. P. Ckll.*) . **confusa coloradensis** (Titus)

A variety of the ♂ of *A. confusa coloradensis*, with the flagellum dark, was taken in S. Boulder Canyon, fls. *Aster lævis*, Aug. 9. (*W. P. Ckll.*)

AGAPOSTEMON Smith

Females . . . . 1.

Males . . . . 5.

1. Abdomen green or bluish . . . . 2.

Abdomen black . . . . 4.

2. Mesothorax with punctures of two sizes . . . . 3.

Mesothorax uniformly punctured or roughened (Colorado etc.) **splendens** Lep.*

3. Base of metathorax without a distinct triangular inclosure, the longitudinal ridges strong (Boulder, fls. *Carduus* oc.) . . . . **texanus** Cresson

Base of metathorax with a more or less evident triangular inclosure, the longitudinal ridges weaker (Boulder, April, fls. *Claytonia lanceolata* and *Pulsatilla hirsutissima*) . . . . **texanus subtilior** Ckll.

4. Larger, 12–14 mm. long; head and thorax bluish (Boulder, fls. *Carduus, W. P. Ckll.*) . . . . **coloradensis** Crawford

Smaller; head and thorax green (Boulder, fls. *Carduus, Linum lewisii* and *Tradescantia universitatis*) . . . . **viridulus** (Fabricius)

5. Hind femora greatly swollen or incrassate . . . . **splendens** Lep.*

Hind femora only slightly or not swollen . . . . 6.

6. Last ventral segment with a median carina . . . . . . **viridulus** (Fabricius)

Last ventral segment without a median carina . . . . . . **texanus** Cresson

The above table is adapted from that of Crawford. The males have the abdomen banded with black and yellow, and look very unlike the females.

NOMIA Latreille

Abdomen black, with light pearly-green bands (Colorado etc.) **foxii** Dalla Torre*

Abdomen without such bands; tibiæ of male ferruginous; tegulæ amber-color (Fort Collins, fls. *Solidago*, August) . . . . **bakeri** Ckll.*

DIANDRENA Cockerell

Similar to *Andrena*, but with only two submarginal cells.

Male 8 mm. long, olive-green; legs, antennæ and mandibles black; female just over 9 mm. long, olive-green to bluish-green (Boulder, in May) **nothocalaidis** Ckll.

ANDRENA Fabricius

Females . . . . 1.

Males . . . . 25.

1\. Thorax and first four segments of abdomen above covered with bright fox-red hair (Boulder, *G. Hite*) . . . . **hitei** Ckll.

Not so . . . . 2.

2\. Tegument of abdomen red, more or less marked with black . . . 3.

Tegument of abdomen not red . . . . 4.

3\. Pubescence fulvous; basal joints of antennæ more or less strongly ferruginous (Boulder, fls. *Pulsatilla*, May 2, *Marie Gill*) . . . . . . **prunorum** Ckll.

Pubescence usually paler; antennæ entirely dark (Boulder, fls. *Pulsatilla* and *Odostemon*) . . . . **prunorum gillettei** Ckll.

4\. Black, with entirely black hair (Boulder, fls. *Ribes*) . . . . **porteræ** Ckll.

At least some of the hair not black . . . . 5.

5\. Abdomen with a decided metallic (greenish or bluish) tint; rather small species, about 9 mm. long, with rather weak white hair-bands on abdomen . . . 6.

Abdomen not metallic . . . . 7.

6\. Stigma amber-color or ferruginous (Boulder, fls. *Salix*, *H. House* and *Ckll.*, also fls. *Odostemon*) . . . . **candida** Smith.

Stigma dark (Boulder, fls. *Hydrophyllum*, May 22, *Ckll.*) . **geranii** Robertson

7\. Hind tarsi clear-red; hind tibiæ largely or wholly red . . . . 8.

Hind tarsi and tibiæ (excluding the hair) brown or black . . . 10.

8\. Thorax above covered with fulvous hair; insect 8 mm. long (Boulder, June 4) **wilmattæ** Ckll.

Thorax above with whitish hair . . . . 9.

9\. Larger; punctures of mesothorax small and rather feeble (Boulder, fls. *Cratægus colorado* Ashe=*C. coloradensis* Nelson,[1] May 20) . . . **claytoniæ** Robertson

Smaller; punctures of mesothorax exceedingly large and deep (Boulder, June, *W. P. Ckll.*) . . . . **perforatella** Ckll.

10\. Hair of face and pleura black . . . . 11.

Hair of face wholly or mainly pale . . . . 12.

11\. Larger, about 11 mm. long; hair of thorax above fox-red; abdomen shining black, without bands (Boulder and Gregory Canyon, fls. *Odostemon*, April) **berberidis** Ckll.

Smaller, about 8 mm. long; hair of thorax above brown; abdomen with feeble hair-bands (Boulder, fls. *Pulsatilla hirsutissima*, April 19, *Marie Gill*) . . **nigrihirta** (Ashmead)

12\. Very small species, about or little over 6 mm. long . . . . 13.

Much larger . . . . 14.

13\. Flagellum bright red beneath (Boulder, fls. *Salix*) . . . . **salicinella** Ckll.

[1] *Cratægus colorado* has cream-colored anthers; those of *C. occidentalis* are pink.

Flagellum dark (Boulder, fls. *Drymocallis*, May 24) . . **fragariana,** Grænicher

14. Hair-bands of abdomen very conspicuous . . . . 15.
Hair-bands feeble or wanting . . . . 17.

15. Larger, about 11½ mm. long; hair of thorax very yellow (Ft. Collins) . . . **mentzeliæ** Ckll.*
Smaller, hair of thorax not thus yellow . . . . 16.

16. Punctures of abdomen stronger and closer; flagellum dark (Boulder, fls. *Pulsatilla*, April, *Marie Gill*) . . . . **bridwelli** Ckll.
Punctures of abdomen weaker and less close; flagellum largely bright red beneath (Boulder, June, *W. P. Ckll.*) . . . . **gardineri** Ckll.

17. Mesothorax with few, widely scattered, strong punctures (Boulder, May 21, *G. Hite*). **nuda** Robertson
Mesothorax not so . . . . 18.

18. Stigma very small; large species visiting sunflowers in August (Boulder, *W. P. Ckll.*) . . . . **helianthi** Robertson
Stigma normal . . . . 19.

19. Abdomen with long erect grayish-white hair, not hiding the surface; hair of pleura white (Boulder, fls. *Salix*, *H. House*) . . . . . . **cockerelli** Grænicher
Abdomen without such hair . . . . 20.

20. Hair of pleura black; abdomen beyond second segment with coarse black hair; first two segments and thorax above with whitish hair (Ward, July, fls. *Edwinia*) **edwiniæ** Ckll.
Hair of pleura black; abdomen beyond second segment with black hair; first two segments with very scanty dark hair; thorax above with bright fox-red hair. (Boulder, June, fls. *Lupinus*) . . . . **lupinorum** Ckll.
Hair of pleura at least mostly black; abdomen shining black, with scanty black hair; thorax above with pale ochraceous hair (Boulder, fls. *Pulsatilla hirsutissima*, April, *E. Bethel*) . . . . **carlini** Ckll.
Hair of pleura light . . . . 21.

21. Area of metathorax coarsely sculptured; abdomen strongly though finely punctured; hair at apex of abdomen red (Boulder, *S. A. Rohwer*) . . . **cratægi** Robertson
Area of metathorax granular, or feebly plicatulate toward base . . 22.

22. Hair at apex of abdomen black or sooty, of thorax above whitish or ochraceous. 23.
Hair at apex of abdomen red . . . . 24.

23. Much larger, anterior wing about 10 mm., abdomen black without conspicuous hair (Castle Rock, Boulder Canyon, May, *S. A. Rohwer*). . **vicina** Smith
Much smaller; first abdominal segment with some conspicuous light hair; vertex with black hair (Ward, fls. *Gilia* and *Drymocallis*) . . . . . **birtwelli** Ckll.

24. Hair of thorax above orange-fulvous, bright on scutellum (Boulder, fls. *Rubus deliciosus*, May 22, *Ckll.*) . . . . **viburnella** Grænicher
Smaller; hair of thorax above gray, of apex of abdomen very bright red (Boulder, *W. P. Ckll.*) . . . . **pyrura** Ckll.

25. Tegument of abdomen partly red; clypeus yellow with two black dots **prunorum gillettei** Ckll.
Tegument of abdomen not red . . . . 26.

26. Hair of face long and entirely black . . . . **nigrihirta** (Ashmead)
Hair of face not, or not entirely, black . . . . 27.
27. Clypeus and lower corners of face yellow . . . . **bridwelli** Ckll.
Clypeus yellow, but not sides or corners of face . . . . 28.
Clypeus not yellow . . . . 29.
28. Malar space very large (Boulder, fls. *Ribes*) . . **leptanthi** Viereck & Cockerell
Malar space rudimentary . . . . **helianthi** Robertson
29. Flagellum red beneath; small species . . . . **salicinella** Ckll.
Flagellum dark . . . . 30.
30. Very small, little over 5 mm. long . . . . **fragariana** Grænicher
Larger . . . . 31.
31. Abdomen with a purplish tint, and thin white hair-bands . **geranii** Robertson
Abdomen not metallic . . . . 32.
32. Abdomen with broad conspicuous hair-bands; hair of thorax above very yellow **mentzeliæ** Ckll.*
Abdomen not thus banded . . . . 33.
33. Area of metathorax coarsely sculptured . . . . 34.
Area of metathorax granular; sides of face with black hair . . . 35.
34. Flagellum conspicuously moniliform . . . . **claytoniæ** Robertson
Larger; flagellum hardly moniliform . . . . **cratægi** Robertson
35. Larger; hair of thorax wholly pale, slightly yellowish . . . . . **carlini** Ckll.
Smaller; hair of thorax grayish-white, with some black . **cockerelli** Grænicher

A female of *A. prunorum gillettei*, taken at Boulder, May 11, at flowers of *Salix*, is peculiar for having the red on the abdomen confined to the hind margins of the segments, so that it looks like a very handsome new species.

From an observation made by my wife, there is reason to believe that *A. porteræ* and *A. leptanthi* are the sexes of one species, notwithstanding their entirely different appearance. If so, the insect formerly cited as the female of *leptanthi* must represent an undescribed species.

HALICTOIDES Nylander

Larger, at least 9 mm. long; intense black, face with black hair (Ward, fls. *Gilia*) **maurus** (Cresson)
Smaller, much less than 9 mm., hair of face not black (Ward, fls. *Drymocallis*) **harveyi** Ckll.

The male *harveyi* has a dense brush of pure white hair covering the clypeus. *Halictoides* looks much like *Panurginus*, but the marginal cell is pointed, not truncate.

PANURGINUS Nylander

Clypeus yellow, but no other yellow on face; first recurrent nervure almost or quite meeting first transverso-cubital; male (Ward, fls. *Drymocallis*) **cressoniellus** Ckll.
Clypeus and a large mark on each side of face yellow; male . **innuptus** Ckll.
Clypeus black, females . . . . 1.
1. First recurrent nervure entering second submarginal cell at a considerable distance from its base; nervures ferruginous (Boulder, fls. sunflower, Aug. 8, *W. P. Ckll.*) **innuptus** Ckll.

First recurrent nervure meeting, or almost meeting, first transverso-cubital; nervures dark . . . . 2.

2. Flagellum ferruginous beneath . . . . **cressoniellus** Ckll.
Flagellum dark (Ward, fls. *Calochortus*). . . . . **cressoniellus calochorti** Ckll.

P. cressoniellus (*clypeatus* Cresson) was originally based on a male. As shown above, and in more detail in *Ann. Mag. Nat. Hist.*, Feb. 1906, there are two forms of the female. The one first made known was assumed to be true *cressoniellus*, but it is not certain which really belongs to the described male, nor whether the males corresponding to the two females can be distinguished.

SPINOLIELLA Ashmead

Clypeus all light except dots and edge, face densely bearded with white hair. **australior** Ckll.♂*
Clypeus only partly light; females . . . . 1.

1. Band on third abdominal segment always interrupted; fifth segment black, with neither lands nor spots (Fort Collins) . . . . **australior** Ckll.*
Band on third segment usually entire; fifth segment largely pale (Florissant) **scitula** (Cresson)*

S. australior usually visits *Peritoma serrulatum*.

PERDITA Smith

Pale yellow (Denver, fls. *Nuttallia*, July, *S. N. Dunning*) . . **wootonæ** Ckll.*
At least head and thorax mainly dark . . . . 1.

1. Abdomen light yellow, with dark bands (Ft. Collins, fls. *Peritoma*) **zebrata** Cresson*
Abdomen dark brown or black, with or without light marks . . . . 2.

2. No light supraclypeal mark . . . . 3.
The supraclypeal region yellow (Boulder) . . . . **affinis** Cresson♂

3. Light markings of abdomen large, oblique, some reaching lateral margin **affinis** Cresson♀
Light markings of abdomen smaller, transverse, not reaching lateral margin, in female, absent in male; female with clypeus and lateral face-marks white; male with face hairy, and lateral face-marks reduced to dots; flagellum light orange beneath in both sexes (South Boulder Canyon, many at fls. *Grindelia*, Aug. 9, *T. & W. Ckll.*) . . . . **ignota** Ckll.

No doubt many more species of *Perdita* will eventually be found in Boulder county. *P. punctata* (Ckll.) and *P. rectangulata* Ckll. occur at flowers of *Solidago* at Ft. Collins.

GREELEYELLA Cockerell

Female about 9 mm. long, brown-black, very shiny; two submarginal cells; marginal cell broadly obliquely truncate; first recurrent nervure meeting, or almost meeting, first transverso-cubital; male with broad head and light yellow clypeus (Boulder, fls. *Malvastum*, June, *W. P. Ckll.*) . . . . . . **beardsleyi** Ckll.

NOMADA Fabricius

Abdomen chestnut red, without light bands. . . . . 1.
Abdomen with conspicuous light bands . . . . 4.

1. Hind margins of abdominal segments black or blackish . . . . . . 2.
Hind margins of abdominal segments not darkened . . . . 3.
2. Hind margins very black; segments 4 and 5 each with two yellow spots (Boulder, June, *W. P. Ckll.*) . . . . **packardiella** Ckll.
Hind margins not very black; no yellow spots (Boulder, April, fls. *Pulsatilla*) **pulsatillæ** Ckll.
3. Basal nervure arising far basad of transverso-medial; mandibles bidentate (Boulder, fls. *Drymocallis*) . . . . **lepida** Cresson♀.
Basal nervure arising little basad of transverso-medial; mandibles simple; abdomen distinctly punctate (Boulder) . . . . **martinella** Ckll.♀
4. Scutellum black; tegulæ yellow, hair of thorax above fox-red (Boulder, fls. *Ribes*) . . . . **collinsiana** Ckll.♂
Scutellum red . . . . 5.
Scutellum yellow; tegulæ yellow; pleura with a large yellow mark; bands of abdomen bright yellow; scape bright yellow (Boulder, June, *W. P. Ckll.*) **ornithica** Ckll.
Scutellum spotted . . . . 6.
5. Face and antennæ red; hair of thorax above red . . . . **collinsiana** Ckll.♀
Clypeus and sides of face yellow; antennæ yellow beneath, flagellum above partly black and partly reddish (Boulder, fls. *Senecio*, June, *W. P. Ckll.*) . . **articulata dacotana** Ckll.
6. Tegulæ bright red; antennæ long, the flagellum black above and red beneath; male (Cheyenne Canyon, May, *W. P. Ckll.*) . . . . . **fragilis** Cresson*
Tegulæ yellow, with a pale or reddish spot . . . . 7.
7. Abdominal bands cream-color; antennæ yellow beneath . . **martinella** Ckll.♂
Abdominal bands bright yellow . . . . 8.
8. Mandibles strongly bidentate . . . . **lepida** Cresson♂
Mandibles simple; flagellum red beneath (Boulder, fls. *Pulsatilla*, May 1, *Marie Gill*) . . . . **subrutila** Lovell & Ckll.

Other species will doubtless be found. *N. uhleri*, Ckll., *N. coloradella* Ckll., and *N. alpha* Ckll., were described from Fort Collins; *N. gillettei* Ckll. and *N. agynia* Ckll. from Golden.

EPEOLUS Latreille

Anterior middle of mesothorax with two clean-cut club-shaped ochraceous stripes; scutellum red (Boulder, fls. *Townsendia grandiflora*, July, *W. P. Ckll.*) **interruptus** Robertson
Anterior middle of mesothorax washed with ochraceous, and with no clean-cut stripes; scutellum black (near Florissant) . . . . . . **beulahensis** Ckll.*

TRIEPEOLUS Robertson

Large, length over 13 mm.; legs black; upward extension of light band at sides of second abdominal segment forming an angle with the band (within) of about 45° (Boulder, Aug. 26, 1906, *Rohwer*) . . . . **martini** (Ckll.)
Much smaller; legs red . . . . 1.

1. Anterior femora bright red; lateral teeth of scutellum much smaller; apex of abdomen narrower, last ventral segment curved downward (Boulder, fls. *Grindelia*, Aug., *W. P. Ckll.*) . . . . **grindeliæ** Ckll.
Anterior femora black above; lateral teeth of scutellum much larger; apex of abdomen broader, last ventral segment not curved downward (South Boulder Canyon, Aug. 9, 1906, *W. P. Ckll.*) . . . . **helianthi** Robertson
Mr. Rohwer notes of *T. martini* ♀, "upper part of eyes in life lemon-yellow, rest black."

BOMBOMELECTA Patton

Thorax and basal segment of abdomen above with red hair, rest of abdomen black without spots (Boulder, fls. *Pulsatilla hirsutissima*, April, *W. P. Ckll.*) **fulvida** (Cresson)
Abdomen with six conspicuous light spots (near Ft. Collins) . **johnsoni** Ckll.*

CŒLIOXYS Latreille

Female about 12 mm. long; legs red (Boulder, fls. *Grindelia*, Aug. 20, *W. P. Ckll.*) **deplanata** Cresson

CHELYNIA Provancher

Abdomen black with ivory-colored bands (Florissant) . **monticola** (Cresson)*
Abdomen blue with whitish or very pale yellowish bands . . . . . . 1.
1. Larger, abdomen with four bands; hair of pleura black (Boulder, fls. *Astragalus*, June, *W. P. Ckll.*) . . . . **pulchra** (Crawford), var. ♀
Smaller, abdomen with five bands; hair of pleura light (Florissant) **elegans** (Cresson) ♂*

STELIS Panzer

Blue, with black hair; no light markings; looks like a small *Osmia* (Florissant) **montana** Cresson*

ANTHIDIUM Fabricius

Females . . . . 1.
Males . . . . 7.
1. Face all black . . . . 2.
Face with light markings . . . . 3.
2. Scutellum all black; scopa strongly stained with brown (Boulder, fls. *Psoralea tenuiflora*, Aug. 8, *W. P. Ckll.*) . . . . **tenuifloræ** Ckll.
Scutellum with light markings; scopa white (Ward. fls. *Phacelia*) . . . **emarginatum** (Say)
3. Clypeus black, but sides of face with pale marks; scopa white (Boulder, fls. *Psoralea*, Aug. 8, *W. P. Ckll.*) . . . . **porteræ personulatum** Ckll.
Clypeus at least partly light . . . . 4.
4. Abdominal bands entire; size large; scutellum with two yellow spots (Boulder, fls. *Helianthus lenticularis*, Aug. 29, 1906, *Rohwer*) . . . **occidentale** Cresson
Abdominal bands interrupted in the middle . . . . 5.
5. Lateral yellow face-marks extending above level of antennæ; large species with bright yellow markings; scopa pale reddish-yellow (Ward, fls. *Phacelia*) **conspicuum** Cresson

Lateral face-marks not extending above level of antennæ . . . . . . 6.

6. Larger; yellow on clypeus interrupted in middle (Boulder, fls. *Grindelia*, Aug. 7, *W. P. Ckll.*) . . . . **porteræ** Ckll.

Smaller; yellow on clypeus not interrupted in middle; upper part of clypeus with a large W-like black mark; sixth abdominal segment bright lemon-yellow (Boulder, June, *G. Hite*) . . . . **blanditum prædentatum** Ckll.

7. Smaller; scutellum all dark . . . . **tenuifloræ** Ckll.

Larger; scutellum at least with yellow dots . . . . 8.

8. Lateral face-marks extending above level of antennæ; large species; abdominal bands not interrupted in middle . . . . **occidentale** Cresson

Lateral face-marks not extending above level of antennæ . . . . . . 9.

9. Ground color of abdomen a more or less lively red; last segment red (Boulder, fls. *Psoralea*, Aug. 8, *W. P. Ckll.*) . . . . **porteræ amabile** Ckll.

Ground color of abdomen dark . . . . 10.

10. Apical segment red; size large . . . . **porteræ** Ckll.

Apical segment black . . . . 11.

11. Abdomen spotted, though some of the spots are united by lines; axillæ with light spots . . . . **porteræ personulatum** Ckll.

Abdomen banded, though the bands are partly interrupted; axillæ without light spots . . . . 12.

12. Markings of abdomen light yellow . . . . **emarginatum** (Say)

Markings of abdomen deep chrome yellow (Fort Collins) . . . **titusi** Ckll.*

DIANTHIDIUM Cockerell

Females . . . . 1.

Males . . . . 4.

1. Legs red . . . . 2.

Legs yellow and black, or black with yellow marks . . . . 3.

2. Smaller; clypeus all black; scopa white (Boulder, fls. *Psoralea*, Aug. 8, *W. P. Ckll.*) **concinnum** (Cresson) var.

Larger; clypeus light at sides (Boulder, fls. sunflower, Aug. 8, *W. P. Ckll.*) **sayi** Ckll.

3. Abdominal markings deep yellow; clypeus light at sides (Boulder, nesting in hole in brick wall at Kruger's house, Aug 2. *Ckll.*, South Boulder Canyon, fls. *Grindelia*, Aug. 9, *W. H. Ckll.*) . . . . **parvum** (Cresson)

Abdominal markings very pale yellow (Boulder, September, *S. A. Rohwer*) **pudicum** (Cresson)

4. Legs red (Boulder, fls. *Grindelia*, Aug. 7, *W. P. Ckll.*) **sayi** Ckll. (*interruptum* Say)

Legs yellow and black (Boulder, fls. *Grindelia*, Sept. 3, *Ckll.*, fls. *Grindelia* and *Chrysothamnus*, Sept., *Rohwer;* S. Boulder Canyon, fls. *Grindelia*, Aug. 9) **parvum** (Cresson)

OSMIA Panzer

Females . . . . 1.

Males . . . . 21.

1. Black without any metallic colors; looks like *Monumetha*, but eyes diverging above;

clypeus with a strong, smooth and shining, longitudinal median ridge (Boulder, June, *W. P. Ckll.*) . . . . **hypocrita** Ckll.
Very brilliant blue or green; scopa black . . . . 2.
Dark blue or green, or black with blue or purple tints. . . . . . . 3.

2. Abdomen long and parallel-sided; tegulæ piceous with a green spot in front (Ward, fls. *Edwinia*) . . . . **fulgida** Cresson
Abdomen shorter; tegulæ wholly green (Boulder) . . . . . **bruneri** Ckll.

3. Large species; hair of thorax above bright fox-red; hair of clypeus and adjacent sides of face black; scopa black (Boulder, June, *W. P. Ckll.*) **novomexicana** Ckll.
Hair of thorax above not thus brilliant . . . . 4.

4. Pubescence, including ventral scopa, white (Boulder, June, *W. P. Ckll.*) **hesperella** Ckll.
Ventral scopa reddish; edge of clypeus 4-dentate (Boulder, May, *Rohwer*) **hypochrysea rohweri** Ckll.
Ventral scopa black. . . . . 5.

5. Hair of pleura white . . . . 6.
Hair of pleura black (white in lower part in one small species, *hypoleuca*) 9.

6. Hair of face all white (Boulder, June, *W. P. Ckll.*). . . . **coloradella** Ckll.
Hair of face not, or not all, white; small species . . . . 7.

7. Legs metallic; vertex and face with very coarse black bristles (Ward, July, fls. *Pentstemon*) . . . . **pentstemonis** Ckll.
Legs black . . . . 8.

8. Scutellum with long black hairs among the white; front brightly colored (Ward, July, fls. *Phacelia:* Boulder, June, 17, *W. P. Ckll.*) . . . . **phaceliæ** Ckll.
Scutellum without black hairs; front black or very dark (Ward, July, fls. *Phacelia*) **melanotricha** Lovell & Cockerell

9. Thorax above with white hair; large species . . . . 10.
Thorax above with black hairs among the light . . . . 12.

10. Mandibles 4-dentate, massive; hair of pleura very short and scanty (Boulder, June 10, *W. P. Ckll.*) . . . . **brevihirta** Ckll.
Mandibles 3-dentate; hair of pleura long . . . . 11.

11. Second abdominal segment with much hair; abdomen dark blue (Boulder, June 9, *Ckll.;* June 17, *W. P. Ckll.*) . . . . **nigrifrons** Cresson, var.
Second abdominal segment with black hair; abdomen very shiny, green, with the hind margins of the segments purple (Arapahoe Peak, Sept. 1, *Rohwer*) **hendersoni** Ckll.

12. Mandibles 3-dentate . . . . 13.
Mandibles 4-dentate . . . . 16.

13. Large species . . . . 14.
Small or rather small species . . . . 15.

14. (Colorado, etc.). . . . . **nigrifrons** Cresson
Differing from *nigrifrons* by having the punctures of the third abdominal segment much more distinct and separate; the hair at sides of metathorax white; a tuft of long white hair on and around tubercles; and the sides of face greener. No appressed light hair on cheeks. Length about 11½ mm. (Boulder, fls. *Gaillardia*, July 6, *W. P. Ckll.*) . . . . **gaillardiæ** Ckll.

15. Larger, length a little over 9 mm.; lower part of pleura without white hair; legs not metallic (Ward, July, fls. *Gilia*) . . . . **wilmattæ** Ckll.
Smaller; lower part of pleura with white hair; legs metallic (Boulder, June 9, *W. P. Ckll.*) . . . . **hypoleuca** Ckll.

16. Small species; hair of sides of face mixed black and white (Halfway House, Pike's Peak, fls. *Salix*, May 30) . . . . **pikei** Ckll.*
Large species . . . . 17.

17. Cheeks with a large tooth below; mandibles much produced; clypeus smooth and shining (Eldora, Aug. 31, fls. *Gaillardia*, *Rohwer*, Ward, fls. *Senecio* and *Frasera*) **armaticeps** Cresson
Cheeks without such a tooth below . . . . 18.

18. Mandibles with a large outstanding basal process; clypeus deeply emarginate. (Boulder, Ward, fls. *Phacelia*) . . . . **propinqua** Cresson
Mandibles without such a process . . . . 19.

19. Smaller; head and thorax strongly blue and green; base and sides of second abdominal segment with short white pubescence (Boulder, June 12, *W. P. Ckll.*) **senior** Ckll.
Larger; head and thorax very dark; hair at base of second abdominal segment black . . . . 20.

20. Smaller; clypeus densely punctured (Ward, July, fls. *Senecio*) . . **wardiana** Ckll.
Very large and robust; clypeus with well-separated punctures (Boulder, fls. *Carduus*, *Ckll.*; Boulder, June 22, *G. Hite.*) . . . . **pascoensis** Ckll., var.

21. Black . . . . here should come the unknown ♂ of **hypocrita**
Dark blue or green . . . . 22.

22. Vertex with hair wholly pale . . . . 23.
Vertex with hair at least partly black . . . . 25.

23. Very small; hair of hind femora white; legs metallic; hind margins of abdominal segments dark; flagellum darker than in typical *proxima* (Boulder, fls. *Phacelia*, June 12, 1905, *W. P. Ckll.*) . . . . **proxima** Cresson, var.
Hair of hind femora black . . . . 24.

24. Small, green, with small ocelli and narrow face (Boulder, June 4, *W. P. Ckll.*) **wheeleri** Ckll., var.
Larger, bluer, with large ocelli (Boulder, June 4, 9 and 10, *W. P. Ckll.*) . . **cyaneonitens** Ckll.

25. Hair of upper part of pleura largely, but not all, black; large species (Boulder, May 20, *Rohwer*) . . . . **viridior** Ckll.
Hair of upper part of pleura all black; flagellum moniliform; hind basitarsus toothed (Boulder, April 20, fls. *Pulsatilla hirsutissima* and *Claytonia lanceolata*) species agreeing with *lignaria* Say, but as the females of this group (*Ceratosmia*) taken at Boulder are all *propinqua*, I infer that they belong to that species, the two not being separable in the male.
Hair of upper part of pleura not black . . . . 26.

26. Larger; hair of face and thorax yellowish, the latter with long black hairs interspersed (Boulder, April 20, fls. *Pulsatilla hirsutissima*) . . . **olivacea** Ckll.
Smaller . . . . 27.

27. Hair of face and thorax above white, the latter with black hairs interspersed; face

narrow (Boulder, fls. *Pulsatilla hirsutissima*, April 20, *W. P. Ckll.*) **pulsatillæ** Ckll.
Hair of thorax without black hairs interspersed (Boulder, April 20, fls. *Pulsatilla hirsutissima*) . . . . **aprilina** Ckll.

MONUMETHA Cresson

Black with parallel-sided abdomen; face of male with appressed white hair (Ward, fls. *Phacelia* and *Frasera*) . . . . **albifrons** Kirby (**argentifrons** Cresson)

ALCIDAMEA Cresson

Black, about 7 mm. long; male with very thick flagellum (Boulder, fls. *Phacelia*) **simplex** Cresson
Grænicher found this species nesting in dry stems of blackberry, etc.]

ASHMEADIELLA Cockerell

Female length 6 to 7 mm.; head and thorax black; abdomen black, with first dorsal segment red except a central mark, second red at sides, third partly red (Fort Collins) . . . . **gillettei** Titus*

HERIADES Spinola

Length 8 mm. or over; black; mandibles of female with a tubercle on outer side; ventral scopa white (Boulder, fls. *Clematis ligusticifolia*, July, *W. P. Ckll.*) **gracilior** Ckll.

LITHURGUS Berthold

Large, *Megachile*-like; apex of female abdomen with red hair, of male abdomen sharply pointed (Boulder, fls. *Opuntia*) . . . . **apicalis** Cresson

MEGACHILE Latreille

Females . . . . 1.
Males . . . . 11.
1. Abdomen without bands; first two dorsal segments and base of third with light hair, the others with black; scopa red . . . . 2.
Abdomen with more or less conspicuous hair-bands . . . . 3.
2. Little or no black hair on vertex and mesothorax (Boulder, Aug., *W. P. Ckll.*) **wootoni** Ckll.
With conspicuous black hair on vertex and mesothorax (Ward, fls. *Lupinus*) **wootoni calogaster** Ckll.
3. Cheeks with an enormous tooth beneath; mandibles greatly elongated (Boulder, Ward, fls. *Geranium, Carduus*) . . . . **pugnata** Say
Not so . . . . 4.
4. Ventral scopa largely or wholly red or orange . . . . 5.
Ventral scopa white or creamy-white, with or without black at extreme apex 7.
5. Smaller, length less than 12 mm.; head and thorax above with some conspicuous black hair (Boulder, September, *Rohwer*) . . . . **relativa** Cresson
Larger, length over 13 mm. . . . . 6.
6. Abdomen heart-shaped; hair of mesothorax mainly grayish-white (Ward, South Boulder Canyon, Boulder; fls. *Phacelia, Senecio, Psoralea, Grindelia*) **latimanus** Say

Abdomen narrower, oblong, shiny; hair of mesothorax largely or mainly black (Ward, Boulder, fls. *Phacelia, Grindelia*) . . . . **vidua** Smith

7\. Small, length not over 11 mm. (Boulder, fls. *Phacelia, W. P. Ckll.*) . **brevis** Say
Larger, length 12 mm. or more . . . . 8.

8\. Middle of clypeus with feeble, sparse punctures (Boulder, *W. P. Ckll.*, July 3, fls. *Opuntia*) . . . . **opuntiarum** Ckll.
Middle of clypeus with strong punctures . . . . 9.

9\. Smaller; abdomen oblong, rather narrow; middle tarsi slender (Boulder, fls. *Argemone intermedia*, Aug. 27, *Ckll.*) . . . . **montivaga** Cresson
Larger; abdomen broad; middle tarsi broadened . . . . . . 10.

10\. Larger and broader, width of abdomen $5\frac{1}{2}$ mm.; pubescence white or grayish-white (Boulder, *W. P. Ckll.*, Aug. 6 to 9, fls. sunflower) . **sexdentata** Robertson
Smaller, not so broad, width of abdomen about $4\frac{1}{2}$ mm.; pubescence with a yellowish tint (Boulder, fls. *Grindelia*, Aug. 21, *Ckll.*) . . . . **manifesta** Cresson

11\. Abdomen without bands, hair on basal $2-2\frac{1}{2}$ segments pale yellowish, beyond that black . . . . 12.
Abdomen with evident narrow hair-bands . . . . 13.

12\. Spurs of hind tibiæ ferruginous; vertex more closely punctured . **wootoni** Ckll.
Spurs of hind tibiæ piceous; vertex less closely punctured **wootoni calogaster** Ckll.

13\. Front tarsi simple . . . . 14.
Front tarsi flattened or excavated . . . . 16.

14\. Spines on anterior coxæ reduced to short teeth or dentiform angles **montivaga** Cresson
Spines on anterior coxæ well developed . . . . 15.

15\. Mandibles 4-dentate, middle tooth notched . . . . **sexdentata** Robertson
Mandibles 3-dentate . . . . **brevis** Say

16\. End of abdomen (keel of sixth segment) with a very large deep notch; hair of face yellow; anterior femur with an oblique keel near apex on outer side . **vidua** Smith
End of abdomen (keel of sixth segment) notched; hair of face cream-color; anterior femur without a subapical keel; middle femur greatly swollen **latimanus** Say
Keel of sixth segment little or not notched; anterior tarsus with a boat-shaped scale or process . . . . 17.

17\. Spines of anterior coxæ slender; keel of sixth segment (seen in lateral view) directed caudad . . . . **pugnata** Say
Spines of anterior coxæ broad and flattened; keel of sixth segment jagged, and directed downward . . . . **manifesta** Cresson

MELISSODES Latreille

Females . . . . 1.
Males; clypeus yellow . . . . 6.

1\. Very large; anterior part of mesothorax with red hair, posterior part with black, the colors contrasting (Boulder, Aug., fls. sunflower, *W. P. Ckll.*, *Rohwer*) **obliqua** Say
Colors on mesothorax different, at least not red in front . . . . . . 2.

2\. Scutellum without black hair . . . . 3.
Scutellum with hair at least partly black . . . . 4.

3. Very large; anterior wing about $10\frac{1}{2}$ mm. long; nervures dark; hair on inner side of hind basitarsus black (Boulder, fls. *Grindelia*, Aug. 7, *W. P. Ckll.*; fls. *Chrysothamnus*, Sept., *Rohwer*) . . . . **mizeæ** Ckll.
Much smaller; nervures ferruginous (Boulder, fls. *Grindelia*, Aug. 21, *Ckll.*) **agilis** Cresson
4. Head extremely broad; hind basitarsus with long white hair on outside, and black on inner (Boulder, fls. *Opuntia*) . . . . **pallidicincta** Ckll.
Head ordinary . . . . 5.
5. Tuft of hair on tegulæ in front black; abdominal bands with a strong orange tint (South Boulder Canyon, fls. *Grindelia*, Aug. 9, *W. P. Ckll.*) . . **grindeliæ** Ckll.
Tuft of hair on tegulæ in front light: abdominal bands grayish white, or only faintly yellowish (Boulder, fls. *Grindelia* and sunflower, Aug. 5 to 7, *W. P. Ckll.*; fls. *Chrysothamnus graveolens*, Sept. 12, *Rohwer*) . . . . . **confusiformis** Ckll.
6. Large; about 14 mm. long; antennæ red beneath . . . . . **obliqua** Say
Much smaller . . . . 7.
7. Mesothorax with a good deal of black hair; tegulæ with a tuft of black hair; labrum black . . . . **grindeliæ** Ckll.
Mesothorax without black hair; small species . . . . 8.
8. Labrum (exclusive of its hair) black; mandibles with no yellow spot; length 10 to 11 mm. (Boulder, fls. *Helianthus*, Aug. 26, *Rohwer*) . . **agilis semiagilis** Ckll.
Labrum black, with a very obscure light spot; spines at sides of last abdominal segment very short; hair of thorax above *very* pale ochreous; mandibles with a very small yellow spot (Boulder, fls. *Grindelia serrulata*, Sept. 5, *Ckll.*) **agilis** Cresson, var. a.
Labrum with a large yellow spot; insect rather large, approaching *M. menuacha*, hair of thorax above practically white; mandibles with no yellow spot (Boulder, July 29, *Ckll.*, at sunflower, Aug. 7, *W. P. Ckll.*) . . . **agilis** Cresson, var. b.
Labrum light except lateral corners; mandibles with a large yellow spot (Boulder, July 29, *Ckll.*, at sunflower, Aug. 7, *W. P. Ckll.*) . . . **agilis** Cresson, var. c.

XENOGLOSSA Smith

Thorax with reddish hair; male clypeus black with a large yellow spot; in flowers of Cucurbitaceæ . . . . **pruinosa** Say *

TETRALONIA Spinola

Females . . . . 1.
Males . . . . 2.
1. Hind spur of hind tibia hooked at end (Boulder, *S. A. Johnson*) **dilecta** Cresson
Hind spur not hooked; abdomen shining black, with only one white hair-band, which is on fourth segment, but a white spot on each side of third **acerba** Cresson
2. Hair of thorax above bright rufo-fulvous (Boulder, fls. *Astragalus*, June, *W. P. Ckll.*) . . . . **astragalina** Ckll.
Hair of thorax above pale or dull . . . . 3.
3. Very large; the entirely black flagellum at least 11 mm. long (Fort Collins) **gillettei** Ckll.*
Not so large . . . . 4.

4. Hair on second abdominal segment all black (Boulder, May 21, 1906, *G. Hite*) **acerba** Cresson

Hair on second abdominal segment partly light; fifth segment with a light band (Boulder, fls. *Phacelia*, June 4, *W. P. Ckll.*) . . **edwardsii vagabunda** Ckll.

The female *acerba* has not been taken in our region. It seems possible that the male assigned to *acerba* is after all a variety of *T. edwardsii.* The specimen of *acerba* taken by Mr. Hite has the peculiarity of possessing only two submarginal cells on both sides. This, if constant, would take it out of true *Tetralonia*, and place it in the old-world genus *Eucera*.

DIADASIA Patton

Hind spur of hind tibia strongly bent at end in female; basal joint of hind tarsus ending in a long process in male (Boulder, Aug. 5, fls. *Opuntia*) **australis** Cresson

EMPHOROPSIS Ashmead

Female with a patch of black hair in middle of thorax, and outer side of hind tibiæ with orange hair; male with face-marks white (Boulder, fls. *Ribes; Mrs. Bennett*) . . . . **johnsoni** Ckll.

ANTHOPHORA Latreille

Abdomen with white bands not due to hair (Boulder, fls. *Psoralea* and *Solanum rostratum*) . . . . **smithii** Cresson

Abdomen without such bands . . . . 1.

1. Thorax above with black and pale hair intermixed, giving a gray effect; middle tarsus of male with copious red hair (Boulder, fls. *Ribes* and *Viola*) **simillima** Cresson

Thorax above without black hair intermixed . . . . 2.

2. Abdomen covered with grayish or fulvous hair; large species (Boulder, fls. *Carduus*, July 29, *Ckll.*) . . . . **occidentalis** Cresson

Thorax and abdomen with bright fox-red hair, but apex of abdomen with black (Ward, fls. *Gilia*, South Boulder Canyon, fls. white aster, Aug. 9, *W. P. Ckll.*) **neomexicana** Ckll.

Thorax and first abdominal segment with dense fulvous hair; rest of abdomen black, with distinct narrow hair bands in male, and vestiges of bands in female (Boulder) . . . . **montana** Cresson

CERATINA Latreille

Small; apical portion of male abdomen narrow; hind femora of male triangular; female with a light mark on clypeus (Boulder, fls. *Calochortus* and *Phacelia*) **nanula** Ckll.

Larger, more robust, female 7 to 8 mm. long; apex of male abdomen broadly triangular (Boulder, fls. *Platycodon, Calochortus, Argemone, Phacelia*) **neomexicana** Ckll.

PSITHYRUS Lepeletier

Large; *Bombus*-like; hair of thorax above fulvous, broadly black between the wings; abdomen shining black, with some light yellow hair at sides toward apex (Ward, fls. *Lupinus*) . . . . **insularis** Smith

BOMBUS Latreille

Abdomen with a very conspicuous red band . . . . 1.
Abdomen without such a band . . . . 6.

1. The red band subapical, with a broad black band before it, and the base of the abdomen broadly pale (Arapahoe Peak, above timber-line, Aug. 31, 1906, *W. P. Ckll.;* Eldora, fls. *Delphinium,* Sept. 1, 1906, *S. A. Rohwer*) . . **frigidus** Smith
(Titus records *frigidus* from Ward as *oregonensis.* He also reports *B. couperi* Cresson, and *B. putnami* Cresson, from Ward. These are similar in most respects to *frigidus.* I examined the types in the Cresson collection, and noted as follows: "*B. putnami* and *couperi* are very similar, with fulvous pubescence, broad black thoracic band, and very broad black abdominal band, occupying the third and fourth segments. *B. putnami* is the larger.")
The red band occupying the third and fourth segments, with no black band before it . . . . 2.
The red band occupying the second and third segments, with a yellow or yellowish band following it . . . . 4.

2. Abdomen beyond the red band with yellow hair; only a little black, on apex of sixth segment (Eldora, fls. *Gaillardia,* Aug. 31, *Rohwer*) . **rufocinctus** Cresson♂
Abdomen beyond the red with black hair . . . . 3.

3. Yellow hair of thorax above without black intermixed (Boulder) **juxtus** Cresson
Yellow hair of thorax above with much black intermixed (Ward, cf. Titus; Eldora, fls. *Gaillardia,* Aug. 31, *Rohwer,* Arapahoe Peak, above timber-line, Aug. 31, *W. P. Ckll.*) . . . . **flavifrons** Cresson

4. Yellow of scutellum and first abdominal segment divided into two spots; form compact (Ward, cf. Titus; Boulder, April and May, *Rohwer*) . **bifarius** Cresson
Yellow of scutellum not divided . . . . 5.

5. Abdomen more elongate, face with fulvous hair (Ward, cf. Titus; Boulder, August etc. *W. P. Ckll., Rohwer*) . . . . **huntii** Greene
Abdomen heart-shaped, face with black hair, a little pale intermixed (Ward, fls. *Phacelia*) . . . . **rufocinctus phaceliæ** (Ckll.)
(In recent years, the validity of *B. bifarius* has been questioned, but it is evidently a perfectly good species. I follow Mr. Franklin in treating *iridis, phaceliæ* and *astragali* as varieties of *rufocinctus.* He has accumulated a large amount of information on this group, which he will shortly publish. Mr. Titus has recorded *B. sylvicola* Kirby, and *B. mixtus* Cresson, from Ward; I have not met with them in Boulder County. *B. sylvicola* was originally described from Lat. 65° N.; the abdomen is yellow with a broad median red band; the apex is, I believe, *not* black, in which case there must be some doubt about the *sylvicola* of Mr. Titus' table (*Canad. Ent.*, 1902, p. 39). *B. mixtus* was described from Colorado; it has the black band between the wings ill-defined.)

6. Thorax black, with the anterior part broadly fulvous-haired; abdomen fulvous with the apex broadly black; large species (Boulder, *G. Weston,* at sunflower, Aug. 7, *W. P. Ckll.;* at *Melilotus alba,* Sept. 27, *Rohwer*) . . **americanorum** Fabricius
(*B. americanorum* is said by Mr. Franklin to be the same as *pennsylvanicus,* but there is much confusion about the latter; Robertson holds it to be *fervidus,* while Pierce has given *auricomus* as *pennsylvanicus.*)

Scutellum with yellow or fulvous hair . . . . 7.
7. No black band between the wings . . . . 8.
A distinct black band between the wings . . . . 12.
8. Abdomen black with first and part of second segment yellow-haired (Boulder, fls. sunflower, Aug. 9, *W. P. Ckll.*) . . . . **separatus** Cresson
Abdomen with the yellow covering first two segments, and at least part of third 9.
9. Lower edge of yellow strongly convex; large species (Boulder, *J. Henderson*, May 11, *Rohwer*) . . . . **morrisoni** Cresson
Lower edge of yellow straight . . . . 10.
10. Face very narrow; apex of abdomen with reddish hair . . . . **nevadensis** Cresson ♂ (*improbus* Cr.)
Face normal ; females . . . . 11.
11. Abdomen with first three segments yellow (near S. Boulder Creek, about 7 miles from Boulder, *Youngblood*, Boulder, August, *W. P. Ckll.*) . **nevadensis** Cresson
Abdomen with the first four segments yellow (Boulder, fls. *Helianthus*, Aug., *Rohwer*) . . . . **dorsalis** Cresson
(The male of *dorsalis* has the abdomen yellow-haired, with only the last segment and the sides of the penultimate black-haired.)
12. Thorax before the band white-haired; abdomen with the hair tawny, and no black band (Boulder, *Ckll.*, Arapahoe Peak, above timber-line, Aug. 31, *W. P. Ckll.*) **appositus** Cresson
Thorax before the band yellow or tawny-haired . . . . 13.
13. Abdomen with the first four segments yellow-haired . . . . . 14.
Abdomen with the basal half at least mainly black-haired . . . 15.
14. Yellow of abdomen suffused with red, especially at sides; hair of face pale (Boulder, *W. P. Ckll.*) . . . . **rufosuffusus** Ckll.
Yellow of abdomen not suffused with red; hair of face black (Boulder, *G. Weston*, fls. sunflower, Aug. 6 and 7, *W. P. Ckll.*) . . . . . . **fervidus** Fabricius
15. Apex of abdomen with pale hair; hair of base black . . . . . . 16.
Apex of abdomen with coarse black hair, but yellow at sides of fifth segment; hair of first and part of second segment pale . . . . 17.
16. First two and fourth segments black, apex white (Boulder, May, *Rohwer*) **proximus** Cresson
First two segments black, third yellow or tawny, fourth to sixth white (Boulder, fls. *Prunus*, May, *Chas. Sellers*) . . . . **proximus coloradensis** Titus
17. The broad black band of abdomen with coppery-red hairs intermixed (Eldora, fls. *Gaillardia*, Aug. 31, *Rohwer*) . . . . **rufocinctus iridis** (Ckll. & Porter)
The band entirely black; appearance of *B. edwardsii* (Boulder, Ward; fls. *Astragalus*, *Phacelia*) . . . . **rufocinctus astragali** Ckll.

APIS L. (domesticated)

Abdomen dark (Boulder) . . . . **mellifera** L.
Abdomen very largely rufo-fulvous (Boulder, fls. *Pulsatilla*, etc.) . . . **mellifera ligustica** Spinola.

POSTSCRIPT

Since the above went to press, the following species have been added to the Boulder County fauna:

Andrena erythrogastra Ashm. Boulder, May 9, fls. *Taraxacum; Mrs. Bennett.*

A. bipunctata Cress. Boulder, fls. *Prunus; G. Hite.*

A. illinoensis Rob. Boulder, fls. *Taraxacum; G. Hite.*

A. pyrrhacita Ckll. Salina, *W. & T. Ckll.;* Boulder, *G. Hite.* A species with dense erect hair covering abdomen, orange-fulvous in color, except at base and apex; much black hair on face.

Nomada cuneata Rob. University Campus, fls. *Taraxacum; Miss Edna Baker.*

N. bella Cress., var. Boulder, fls. *Nothocalais; Mrs. Bennett.*

N. ednæ Ckll. Campus of University, fls. *Taraxacum,* April 10; *Miss Edna Baker.* In table of Rocky Mtn. *Nomada* runs to *superba,* but much smaller, and apical plate notched.

Osmia universitatis Ckll. University Campus, fls. *Taraxacum,* April 10; *Miss Edna Baker.* Male runs in table near *proxima,* but much larger, legs black, abdomen bright steel-blue, the hind margins of the segments dark purple.

O. leonis Ckll. University Campus, fls. *Taraxacum,* May 8; *Miss Edna Baker.* Near to *gaillardiæ,* but with a shining pit next to apical margin of clypeus; hair of thorax above light ochreous, with a little black.

O. gaudiosa Ckll. University Campus, fls. *Taraxacum,* April 10; *Miss Edna Baker.* A small bright-green species, with white pubescence; posterior part of abdomen dorsally with wholly light hair.

O. ednæ Ckll. University Campus, fls. *Taraxacum,* May 9; *Miss Edna Baker.* Allied to *gaudiosa,* but larger, pubescence very yellow; abdomen brilliant, shining golden.

O. bennettæ Ckll. University Campus, fls. *Taraxacum,* May 8; *Mrs. C. Bennett.* Allied to *O. bella,* but no dark hairs intermixed on thorax above. Easily known from *gaudiosa* and *ednæ* by larger size, and black hair on posterior dorsal region of abdomen.

Full descriptions of the new species are about to be published in *Annals & Mag. Nat. History.*

THE PROTOZOA OF THE UNIVERSITY CAMPUS

[Dr. C. H. Edmondson, of the Iowa Wesleyan University, having very kindly offered to work up Protozoa from Boulder, I sent him a small collection of material from the University campus. It all came from the south end of the lake or pond, and from the little marsh immediately south of it, across the road. The number of species reported is so great that it seems worth while to put them on record; and in so doing, I have thrown the list into the form of a key. The characters in the key are derived from Dr. Edmondson's recent excellent work on the Protozoa of Iowa (*Proc. Davenp. Acad. Sci.*, 1906), and in part from Dr. H. W. Conn's *Protozoa of the Fresh Waters of Connecticut* (1905). Dr. Edmondson reports that there were in the gathering a few other species which he did not recognize, and to which he well give further study. The Protozoa of Colorado have hitherto been known from the list given by Professor Arthur E. Beardsley in *Trans. Amer. Micr. Society*, May 1902. This list includes 99 species, of which four are described as new. The list from the University campus includes 45 species, of which 20 are ostensibly absent from Professor Beardsley's list; these are marked below with an asterisk. This would bring the Colorado list up to 119, but there is doubtless some synonymy involved. In writing *Amœba proteus* Leidy, I follow Edmondson and Conn, but according to the rules of nomenclature this name is not valid. Stiles and Hassall (*Bureau of Animal Industry, U. S. Dept. Agric.*, Bull 79, 1905, p. 38) have discussed this matter at some length, arriving at the conclusion, on the principle of "tautonomy," that the animal is entitled to the designation *Chaos chaos* (L.). However, on the "first species" principle, and also on that of "elimination," the generic name *Chaos* does not apply to the amœba, and it is questionable whether it ought to be adopted. Discarding *Chaos*, the name *Amiba*, Bory 1822, takes precedence over the altered spelling *Amoeba* Ehrenberg, 1830, and the common species becomes *Amiba chaos* (L.) based on *Volvox chaos* L., 1758. Beardsley records three other species of the genus from Colorado:

Amiba limax Duj.

Amiba spatula Penard. Having two forms, one radiate, floating, 10–12 μ diameter, the other spatulate, crawling, 20–25 μ diameter.

Amiba radiosa Ehr., with long, slender, pointed pseudopodia; diameter of body up to 45 μ (*A. chaos* reaches 250 μ or over).

It is of interest to record that E. Penard, now so well known as an authority on the Rhizopods, was at one time living in Boulder, the guest of Professor John Gardiner. I have not been able to ascertain that he published anything on the Protozoa of Colorado. T. D. A. COCKERELL]

With or without shells, with pseudopodia lobose, finger-like or raylike and sometimes anastomosing, with or without axial supports (Class *Sarcodina*) . 1.
Small forms provided with one or more flagella; often forming colonies (Class *Mastigophora*) . . . . 5.
With cilia during embryonic and adult life, or (in Subclass *Suctoria*) in embryonic life only (Class *Infusoria*) . . . . 10.

1. Without shells. Pseudopodia lobose or sharp-pointed, sometimes branched (Family *Amœbidæ*) . . . . 2.
With membranous shells with which may be incorporated foreign materials. Pseudopodia lobose or short-pointed, often branched (Family *Arcellidæ*) . . 3.
Shells of plates of chitin or silica, sometimes spined. Pseudopodia sharp-pointed, often branched but not anastomosing (Family *Euglyphidæ*) . . . . . 4.

2. Body of comparatively large size; pseudopodia finger-like or lobose (very abundant) **Amœba proteus** Leidy

3. Shell oval or pear-shaped, sometimes with a short neck and broadly expanded fundus with or without spines, composed mainly of sand-grains **Difflugia pyriformis** Perty
Shell usually of some shade of yellow or brown, about one-half as high as broad, the character of the surface varied; mouth circular, in the center of the ventral surface . . . . **Arcella vulgaris** Ehr.
Shell a delicate, transparent membrane, exceedingly flexible; endoplasm colorless (very abundant) . . . . **Cochlipodium bilimbosum** Leidy*

4. Shell composed of oval plates overlapping each other and arranged in regular rows producing the appearance of hexagonal areas; spines often present **Euglypha alveolata** Duj.
Body inclosed within an elongated, chitinous shell; fundus rounded, oval extremity narrower and obliquely truncate . . . . **Trinema enchelys** Leidy*

5. Flagella one or two, at the base of which is a mouth; often possessing chlorophyll (Order *Euglenida*) . . . . 6.
Plantlike flagellates; flagella two; body elongate-oval, anterior margin with a prominent liplike projection; endoplasm usually including dark-colored corpuscles **Chilomonas paramæcium** Ehr. (Order *Phytoflagellida*)
Body with two transverse furrows; furrow extending wholly round body (Order *Diniferida* or *Dinoflagellata*). . . . . **Gymnodinium** sp.*

6. Elongated forms usually with a single flagellum; pigment spot and chlorophyll often developed (Fam. *Euglenidæ*) . . . . 7.
Body elongated but plastic, with no coloring substance; flagellum single; length of extended body 30–60 μ . . . . **Astasia trichophora** Ehr.
Body persistent in shape and plastic; pharynx distinct; oval, somewhat flattened; flagella two; length of body 22 μ. . . . . . . **Entosiphon sulcatus** Duj.*
Persistent in shape; flagella two, the trailing one very short; ovate, the anterior border acutely rounded, the posterior truncate; length of body 12 μ **Notosolenus opocamptus** Stokes*

7. Body elongate, changeable in form; endoplasm usually bright green in color; eye-spot usually present; flagellum single . . . . 8.

Body flattened, leaflike, with a tail-like posterior prolongation; color usually green; eye-spot present; flagellum single . . . . 9.

8. Body usually rounded anteriorly, with a colorless tail-like posterior prolongation; length of body 50–75 μ . . . . **Euglena viridis** Ehr.[1]

Body elongate, wormlike; color green; length when extended 50–100 μ **Euglena deses** Ehr.*

9. Body flattened, oval in outline, with a short posterior tail-like projection, usually curved; surface longitudinally striated; endoplasm bright green **Phacus pleuronectes** Müll.

Body with a long tapering tail-like projection, usually straight; endoplasm green **Phacus longicaudus** Ehr.*

10. With cilia during entire existence (Subclass *Ciliata*) . . . . . . 11.

With cilia during embryonic life only; with suctorial or piercing tentacles during adult life (Subclass *Suctoria*) . . . . 28.

11. Cilia usually covering the entire body, sometimes slightly longer about the oral aperture; trichocysts often present (Order *Holotricha*) . . . . 12.

Body entirely ciliate, cilia of the oral region longer than those of the general surface and often fused together (Order *Heterotricha*) . . . . 24.

Usually flattened, with cilia confined to the ventral surface (Order *Hypotricha*) 25.

Cilia reduced to one or two wreaths or circles; stalked forms (Order *Peritricha*) 26.

12. With sculptured shell made of numerous pieces; ovate or barrel-shaped, cylindrical, length 60 μ . . . . **Coleps hirtus** Ehr.

Without shell . . . . 13.

13. Cilia uniform over body . . . . 14.

With a single row of large cilia . . . . **Mesodinium** sp.*

Cilia only on ventral surface . . . . 22.

14. Mouth without protruding undulating membrane . . . . 15.

Mouth with protruding undulating membrane . . . . 20.

15. Mouth terminal or nearly so; no proboscis . . . . 16.

Mouth somewhat posterior to anterior end, on the ventral surface; no proboscis 18.

16. With a long neck; not flattened; neck capable of being extended many times the length of the body (very abundant) . . . . **Lacrymaria olor** Müll.

Without a neck; pharynx long and evident . . . . 17.

17. Mouth terminal, provided with minute rodlike teeth; length of body 150–200 μ **Prorodon teres** Ehr.

Mouth eccentric, opening into a conical tube which reaches far into the endoplasm **Prorodon edentatus** C. & L.*

18. Mouth in middle, or posterior; length 230 μ . . **Paramæcium caudatum** Ehr.

Mouth anterior to middle . . . . .19.

19. Elongated oval, wider anteriorly; mouth lateral, appearing as a slotlike opening **Frontonia leucas** Ehr.

[1] In material collected by Lucien Shattuck one or two hundred yards beyond the boundary of the campus we found *Eutreptia viridis* Perty (determined with the assistance of Dr. Edmondson), new to Colorado. It is like an elongate *Euglena*, but with two flagella, and most extraordinary peristaltic movements.

Elongate, nearly cylindrical, the anterior extremity truncate and slightly curved; length 40–70 μ . . . . **Loxocephalus granulosus** S. K.*
Elongated, bean-shaped both extremities evenly rounded, the anterior one curved ventrally; length 100–120 μ (very abundant) . . . . **Colpoda helia** Stokes*
Dr. Edmondson also reports a second species of this genus . . **C. campyla** Stokes*

20. Peristome not evident; mouth near the front; body oval, 75 μ long **Glaucoma scintillans** Ehr.
Persitome evident, posterior to middle; a tuft of long bristles at the posterior end; length 30 μ . . . . **Cinetochilum margaritaceum** Ehr.
Peristome evident, not, or not wholly, posterior to middle . . . **21.**

21. Peristome covering the whole right side, with a large membrane; length 50–100 μ **Lembadion bullinum** Perty
Small (20 μ), ovate, with a posterior seta much longer than the cilia of the general surface (very abundant) . . . . **Cyclidium glaucoma** Ehr.

22. Elongated, with a necklike prolongation . . . . **23.**
Elongated-oval, without a neck; cilia arranged in longitudinal rows **Chilodon cucullulus** Müll.

23. Larger (length 110 μ), contractile vesicle single, posterior (very abundant) **Lionotus fasciola** Ehr.
Smaller (80–100 μ), contractile vesicles numerous **Lionotus pleurosigma** Stokes*

24. Mouth near or posterior to middle of body, preceded by a narrow peristomal furrow; greatly elongated but highly contractile, contracting spirally (very abundant) . . . . **Spirostomum teres** C. & L.*
Peristome occupying the front border; body entirely ciliate; body blue, when extended 250–300 μ long; often in clusters . . . . . . **Stentor cæruleus** Ehr.
Body with anterior ring of cilia; shape spheroidal, length 25 μ **Halteria grandinella** Müll.

25. Elongated-oval or elliptical, very elastic; three prominent frontal styles, and five anal styles; length 80–100 μ . . . . **Oxytricha pellionella** Müll.
Persistent in shape, inflexible, oval, ventral surface flattened, dorsal surface convex and longitudinally furrowed; seven frontal styles and three ventral; length 80 μ (very abundant) . . . . **Euplotes charon** Müll.
Small (35 μ); convex dorsal surface with five or six longitudinal furrows; usually three frontal styles, four or five scattered ventral and five anal **Aspidisca costata** Duj.

26. Stalk not retractile, slender, dichotomously branched, secondary divisions very long . . . . **Epistylis plicatilis** Ehr.*
Stalk retractile . . . . **27.**

27. Body broadly campanulate, greatly dilated anteriorly; stalk usually five or six times length of body; endoplasm dark granular, often opaque; length of body 150 μ **Vorticella campanula** Ehr.*
Body oval, wider centrally, anterior border not greatly dilated: stalk about three times length of body; endoplasm transparent; length of body 55 μ; occurring in social groups . . . . **Vorticella alba** From.*
Body conical, elongate, tapering posteriorly; stalk not much longer than body; length of body 40–50 μ; solitary in its habits . . **Vorticella telescopa** S. K.*

28. Body inhabiting a lorica which is produced posteriorly into a rigid stalk **Acineta** sp.*
Spherical, without a shell, attached by a slender but rigid stalk; diameter of body 55 μ (very abundant) . . . . **Podophrya fixa** Müll.*