IS A SHIP CANAL PRACTICABLE?

NOTES,

HISTORICAL AND STATISTICAL,

UPON THE PROJECTED ROUTES FOR AN

INTEROCEANIC SHIP CANAL BETWEEN THE ATLANTIC AND PACIFIC OCEANS,

IN WHICH IS INCLUDED

A SHORT ACCOUNT OF THE CHARACTER AND INFLUENCE OF THE CANAL OF SUEZ, AND THE PROBABLE EFFECTS UPON THE COMMERCE OF THE WORLD OF THE TWO CANALS, REGARDED EITHER AS RIVALS, OR AS PARTS OF ONE SYSTEM OF INTEROCEANIC NAVIGATION.

BY

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ILLUSTRATED WITH MAPS.

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THE following notes upon Interoceanic Routes across the American Isthmus were collected and arranged during intervals of professional occupation, and are doubtless affected by the haste incident to this method of preparation.

They were laid by a friend before the Hon. WILLIAM H. SEWARD and the late R. J. WALKER, for their perusal, and receiving the commendation of their enlightened judgments, the writer has thought that the publication may not be without interest to those who are seeking information as to the feasibility of an intermarine ship canal between the Atlantic and Pacific Oceans.

Prepared before the completion of the Suez Canal and the sailing of the last Darien Expedition, some additions have been made to bring the parts of the Notes relating to these topics up to date.

AUGUST 1, 1870.

IS A SHIP CANAL PRACTICABLE?

CHAPTER I.

Columbus discovers Darien—Opinions of Berghaus, Humboldt, Garella, Hughes—Expectation of finding a Strait—Influence of Oriental Trade—Names identified with the Project of a Canal—Defeat of Miranda's Scheme—Object—Opinion of Admiral Davis—Sketch of Oriental Trade—Contest for its Possession—Four different Solutions—United States—Russia—France—England—English Diplomacy and the Suez Canal—History of its Difficulties—Empress Eugenie Inaugurates—Dimensions of Canal—Capital of Company—Expenditures—Effects on Commerce—Circumstances affecting the Permanence of the Suez Canal—Teaching of History—Sand Dunes—Inferences from Geology—Sediment of the Nile—Deltas—Silting up of Port Said, and rate of advance of the Shore Line.

UPON the 14th of September, in the year of our Lord 1502, three caravels, bearing Columbus and the destinies of the New World, long baffled by opposing storms and currents, at last doubled Cape Gracias a Dios.

To appreciate the courage of the daring Navigator, it is necessary to call to mind the fact that the largest vessel of this little fleet did not exceed seventy tons burden. With seams opened by the stress of the gales, sails tattered by the winds, hulls eaten to a honey-comb by the teredo, distrust at home, dissension around, and danger everywhere, this great man abated not a jot of his high hopes, but repairing his shattered ships as he was able, continued his adventurous voyage.

The air came to the toil-worn mariners freighted with spicy fragrance, gentle winds wafted them in sight of lofty mountains and of verdant slopes, clothed with the majestic palm and the pink and golden blossoming *flor de Robles*.

The simple-minded natives of Honduras and Costa Rica welcomed them with supernatural devotion, bringing gifts of fruits, gold, gems, and tenders of hospitality.

Strange rumors reached them of a people living in houses of sculptured stone, and occupied in the arts of peace. Columbus could not be diverted from his purpose.

The season was that of gales, and the little fleet was shut in the beautiful harbor of Porto Bello.

The Norther ceasing, the voyage continued as far as the little, craggy Bay of El Retreate; here, near the present Puerto de Mosquitoes, Columbus reached the westward limit of his last voyage of discovery.

Sixty-six years of sorrow and disappointment, of disinterested purposes maliciously opposed, of bold designs ignorantly thwarted, of a pure and illustrious character misjudged and traduced, had humbled the pride and subdued the enthusiasm of that aspiring intellect; and now, at the close of a career of vast and useful discoveries, he was called on to face a trial which Goëthe has affirmed to be the severest and most inexorable of life.

Welcomed with the approving plaudits of his king and countrymen, or loaded with ignominious chains, he had ever kept one object constantly in view. This object, pursued with unexampled courage, self-abnegation, and constancy, he was now called on to renounce. Who will venture to depict the thoughts of this remarkable man as he turned to retrace his path, leaving behind him the prospect of discoveries far greater than those which had cast the hallow of immortal fame around his name?

"Here ended," says Irving, in a strain of tender eloquence, "the lofty aspirations which had elevated him above all mercenary views in his struggle along this perilous coast"——"it is true, he had been in pursuit of a chimera, but it was the chimera of a splendid imagination and a penetrating judgment. If he was disappointed in finding a strait through the Isthmus of Darien, it was because Nature herself was disappointed."

This sagacious conjecture has its foundation in nature, and is supported by the opinions of savans and the facts of recent geological explorations.

The Prussian geographer, Berghaus, as early as 1823, and Prof. Hopkins, contested the accepted opinion as to the unbroken continuity of the Isthmus and the contiguous continents.

The French engineer, Garella, after making a geological reconnoissance, declares that the Isthmus is of more recent origin than the continents which it unites. Col. Hughes and Garella concur in a belief in the existence, at an early period, of a strait uniting the Atlantic and Pacific oceans. The identity of the species of fish inhabiting the waters on both sides of the Isthmus is an additional argument in confirmation of this view.

It is without surprise that we find the discoveries of another science

confirming this inference. Prof. Huxley, in a recent address on the progress of palæontology, is unable to explain the distribution of mammals at the close of the miocene period, except upon the supposition of a barrier which prevented the migration of the apes, rodents, and edentata from the southern to the northern continent. He cites the opinions of Carrick Moore and Prof. Duncan in support of the same conclusion. Further investigation will, no doubt, add to the number of facts which indicate the separation of the two continents by the ancient sea, and may even establish the fact that portions of Central America once formed parts of the Antilles group of the equatorial belt of islands.

General Michler, in his interesting report of the survey of the Atrato, observes: "All the stratified rocks on the Isthmus, exhibiting strong marks of disturbance and even dislocation since they were originally deposited, clearly prove that the upheaval which brought this narrow neck of land above the level of the ocean must have taken place at a comparatively late era. This period was undoubtedly accompanied by the protrusion of certain metamorphosed shistose (?) rocks, the doubtful nature of which has induced us to mark them as belonging to a trappean series. If Darwin had good reason to believe that the granite of South America, now rising into central peaks 14,000 feet in elevation, must have been in a fluid state since the deposition of the tertiary group, we may also do so in pronouncing the formation of the Isthmus, now linking together South and Central America, as decidedly post-tertiary."

The deductions of Columbus were, however, based on the direction of the coast of Cuba, which he supposed to be a continent, and the parallel coast of South America; and was further confirmed by the westerly current flowing between them, which must, he thought, find an outlet near Darien.

These bold generalizations, drawn from stores of profound observation and varied reading, although we now know them to be erroneous, evince the sagacity of the man, and place him far ahead of the intelligence of his age. With heartfelt sorrow he reluctantly renounced a chimera so plausible, which he expected would lead him to the fabulous kingdom of Prester John, or, perhaps, to the marvelous splendors of the imperial dominions of Kublai Kahn, and which would, he believed, open new fields for the peaceful conquests of the banner of the Redeemer.

The delusive representations of travelers was the chief impulse to some of the greatest achievements of the fifteenth and sixteenth centuries.

The coveted wealth of "Ormus and of Ind" was a siren who had lured adventurous navigators to dare the dangers of unknown seas.

The same diversity of motive may be found in the men of that period which now exists and animates the westward course of civilization. Love of money and fame are found contending by the side of the desire to extend the domain of knowledge and zeal for the spread of religion.

The result of these combined passions was to open new avenues to wealth, industry, and science.

Four hundred years have elapsed since the wondering eyes of Spanish discoverers first gazed on the strange beauty of the New World. In this interval a nation of forty millions of people have been planted in the country of Columbus, its wildernesses are traversed by steam, its products supply food and clothing to a large part of the world; but, with all this progress, the visionary strait of the great navigator is yet an unrealized dream.

Impossibilities have been accomplished, poetical fictions have become facts, visionary theories of the past are the industrial arts of the present. In wealth, comfort, health, longevity, art, science, organized labor and charities, the human race of the present have outstripped the Arcadian felicity of the golden eras of Hesiod and Cervantes.

Possessing every facility, occupying a preëminent coigne of vantage, we have left one thing unachieved. This ought we to have done, and not to have left the others undone.

Many minds, speculative and practical, have closely scrutinized the feasibility of making the American Isthmus a highway for the commerce of the world.

Its importance grows in dimensions in proportion to the study bestowed on it. It ranks among its friends some of the most able men of the race.

Columbus, Cortes, Charles V, Alverado, Gonzales de Avila, De Solis, Gomaro, Bautista Antonella, and, in more recent times, Paterson, Pitt, Jefferson, Humboldt, Guizot, Napoleon III, Wheaton, Dallas, Biddle, and a long and honorable list of statesmen and publicists have contributed to the project.

According to the scheme of General Miranda, sanctioned by Wm. Pitt, it was proposed that Great Britain should supply the money and ships, and the United States should send 10,000 men.

The failure of this plan is attributed to delay on the part of President Adams.

The tonnage of the trade which would annually seek this route

has been estimated at 3,094,000 tons, equal in value to $152,475,750. The value of the exports and imports of all the nations which would annually pass the Isthmus would amount to $451,029,132.

With such enormous commercial interests, backed by advocates so able, it is not a little curious that the question of feasibility should be yet unsolved.

Political vicissitudes have often postponed its consideration. Conflicting interest and rivalries have prevented the coöperation long deemed essential to its successful execution.

The hereditary policy of the United States has always been anti-social and insular. Schooled in this policy, it is difficult to enlist the sympathies of our people in questions which are to be answered in regions beyond their jurisdiction.

The utility and practicability of the work must first be made clearly manifest.

Passing in review the present state of our knowledge of Isthmean routes, one of the objects of this paper is to attempt to appreciate the probable advantages which would result from the completion of an intermarine ship canal.

In selecting from material, much of which bears little relation to the questions at issue, many objects may be omitted which deserve notice, and some may be noticed which might have been omitted.

If serious attention is attracted to this important project, the writer will have attained his object.

"There does not exist in the libraries of the world," observes Admiral Davis, "the means of determining, even approximately, the most practicable route for a ship canal across the Isthmus." This deficiency in our geographical knowledge will shortly be supplied. An exploration is now in progress, under the auspices of Government.

If a practicable route is found, there is reason to believe that execution will follow as certainly as the settlement of America followed its discovery.

We may not unreasonably expect the progress of the future to keep pace with the past, and that the absolute increase of the commercial marine, and an enlarged area for its operations, will lead to a proportionate extension of the beneficent influences of religion and civilization. The speculation opens a prospect of the future destiny of intertropical America; destined, perhaps, to produce as great a revolution on our globe as the colonization of America.

"The completion of this work," observes an earnest advocate, "will be the same as if, by some great revolution of the globe, the eastern continent were brought nearer to us."

The produce of the Indies has always been a coveted prize; wealth has followed in its path; commercial supremacy has been the property of its possessor. As changes in the route brought about new political relations, and raised up a more successful competitor for the trade of the Orient, a reconstruction of the map of the world has become necessary.

Its importance may be gathered from the fact that the annual exports and imports of the United States to the East Indies, China, Australia, and the South Pacific Islands amount to $39,380,000, and the aggregate exports and imports of Great Britain to the same points amount to $378,857,000.

If this trade has ceased to be a monopoly, and has lost some of its importance since the colonization of the Americas, it is yet sufficient to hold the guerdon of commercial supremacy. A history of its course and influence is beyond the scope of this paper. A passing notice will show how important a part it has played in the destinies of nations.

It is probable that the wars of ancient Egypt, Assyria, and Babylon were waged for the control of the trade of the East. The expedition of Alexander was not the result of an unreasoning lust for dominion and military glory. The apple of discord then, as now, was the beautiful land of the East. The descendants of the great Aryan and Semitic families, constantly moving westward, never forgot the land of their birth.

At an early period, caravans brought the rich products of India across the desert. Under the influence of this traffic, the palaces of Palmyra sprang up amid the sands. The Saracens drove the course of trade to the Caspian and the Euxine. The Mediterranean felt its beneficent effects, and Venice, Trieste, Marseilles, Cadiz, Barcelona became the marts of its rich and varied commodities.

After the discovery of de Gama, the busy hum of industry began to cease in these once populous emporiums. When Shylock drew up his bloody bond, the trade of the Indies had set around the cape. While commerce was suspended and industry prostrated by wars and civil dissensions, Holland bore off the prize. The devastating armies of Alva threw the Indian trade into the strong hands of Elizabeth.

England now began to lay carefully the foundation of her empire. The policy she now adopted, whether through instinct or forethought, was one which looked beyond the temporary advantages of position and possession. She attempted to make these advantages permanent by the conquest of the territory from whence all these bounties seemed perennially to flow.

The British Empire in India, in its extent, power, wealth, and future possibilities, stands an enduring monument of the courage, energy, and wisdom of the British people. Whether actual possession has secured the reversionary benefit, time alone can show.

That wealth, power, and dominion follow oriental traffic, is now patent to the world. It is no longer the object of secret diplomatic intrigue; it has become an open question, to be solved by the general competition of commercial nations.

In the pursuit of this object, the leader in the Pansclavonic movement is pushing her outposts past India to the wall of China. The United States, conscious of her natural advantage, is awakening to the importance of a systematic policy.

The French Emperor seems at present, by the aid of the Suez Canal, likely to appropriate the lion's share. While American commerce is disappearing from the seas—fifty per cent. of her exports and imports being carried in foreign ships—the flag of France may be seen by the side of England in every sea. The hereditary policy and commercial instinct of the British may prove to be more than a match for the astuteness of one man. Who will ultimately bear off the prize, is a question admitting three possible solutions.

Russia, as has been said, rapidly extending her frontier eastward, stretches out her hand to grasp the trade of the East. The Suez and Darien Canals—the one an unsolved problem, the other an accomplished fact—represent the two other contestants. One of the most constant objects of war and diplomacy has been for the possession of the highway through Egypt for the trade of the East.

It was designated by the Portugese conqueror, Albuqueque, as one of the three important points essential to the "command and monopoly" of this trade. England, anticipating the day when it might be important for her to have the military control of this highway, has persistently established military ports, beginning at Gibraltar and ending at Aiden. She has secured strong posts at Malta and Beb el Mandeb. The Great Leibnitz called the attention of Louis XIV to the commercial and political advantages of a conquest and colonization of this country. Napoleon, flushed with the conquest of Italy, took the initiative in this bold design. By his order, M. Lepere, "a distinguished engineer," completed an examination in 1801. The results of this examination have been published by the Imperial Government.

M. Lepere asserted the practicability of a ship canal along the line of the ancient canal from Suez to the Nile, as far as the Bitter Lakes. From thence its course has to proceed to the Pelusiac

branch of the Nile. Here, on the sea, it encounters the accumulating banks and bars of the Nile, one of the two very serious obstacles to the execution and permanent value of a ship canal between the two seas.

The project of a canal uniting the Red Sea and the Mediterranean appears to have been suggested by M. de Lesseps to Said Pacha, the Viceroy of Egypt, in 1854. The company was definitely formed in 1869.

It is not very easy to estimate the important effects of opening this route to the maritime States of Europe.

Lord Palmerston, acting in the interest of England, constantly opposed the design. He at once perceived that the restoration of trade to the Levantine ports would seriously disturb the commercial equilibrium. All the ingenious devices of a clever lawyer in conducting a bad case were employed by English diplomacy in order to arrest the operations of M. de Lesseps.

The first and most valid objections alleged by Lord Palmerston were based on the practical difficulties in the way of execution, and were stated with great force and acuteness. The shifting sands of the Desert would, it was affirmed, soon fill up the canal; and the sand and silt, which from time immemorial had been brought down by the great father of waters, and which swept to the westward by the prevailing winds, would soon fill up any artificial harbor which might be constructed.

That these difficulties were resolutely encountered and overcome, is one of the marvels of this truly marvelous work.

To these objections M. de Lesseps cautiously replied that all questions would be referred to a commission of engineers.

After an examination of all the plans, the commission reported favorably on that which has just been successfully executed. The work found a few friends among the English people and in Parliament.

Lord Palmerston, being interrogated, declared that the scheme was hostile to the interest of the country. His real objection was obscurely hinted. "It is founded," he remarked, "in remote speculations in regard to easier access to our Indian possessions, which I need not more distinctly shadow forth, because they will be obvious to any body who pays attention to the subject." He further characterized it as one of those plans "so often brought out to make dupes of the English people," and he expressed his preference for the communication by railroad between Suez and Cairo. As this railroad can never be more than a passenger route, it is evident that its influence on commerce must always be insignificant.

The work had barely commenced when, through the instigation of the English Embassador, the Sultan issued an order arresting the operations. The plea assigned for this interference was that the authority of the Viceroy was insufficient without the sanction of the Sultan. De Lesseps invoked the interposition of the Emperor, who, with apparent indifference, was watching the proceedings from his retreat at Biarritz.

Within a month after the presentation of the memorial the misunderstanding between the two cabinets had been explained, and Lord Palmerston was for a time silenced by the consent of Egypt to receive a Turkish garrison. This acquiescence was in appearance only, as the real object of these repeated assaults was to arrest the work. The Viceroy, desirous of silencing all opposition, consulted French jurisconsults in regard to the rights of the company, and definitely settled the powers of the contracting parties.

For a moderate sum he ceded to the company the belt of country bordering the fresh water canal. Immediately the cry was raised by the opponents of the canal, that it was intended to colonize this region with Europeans.

While this matter was in controversy, and the work was steadily proceeding, Said Pacha suddenly died, and Ismail, his nephew, reigned in his stead, with the title of Khédivé. He confirmed the concessions of his predecessor and entered into new conventions. His confidence in the work, which had appeared uncertain, was established by the able report of Sir John Hawkshaw, the President of the Society of Civil Engineers. This report, however, which was confirmed by the personal inspection of Sir Henry Bulwer, aroused all the fears of the English Government. The success of the work, at first problematical, now seemed more than probable. A decisive blow must be struck; one that should be fatal to the undertaking.

Throughout Egypt, according to an ancient and still prevailing custom, private and public work is executed by a system of forced labor, termed Corvē. The conscription is limited to the period of one month, at a fixed rate of wages. The company engaged to pay higher rates than usual, and to supply food, lodging, medical attendance, and half pay when sick. No sooner had twenty thousand men been collected on the excavations, than a "howl went up from Exeter Hall." Lord Stratford de Redcliffe demanded of the Sultan "to stop the scandal."

The British Government were instantly seized with one of those sudden spasms of morality, or humanity, which Lord Macaulay affirms has been observed periodically to afflict the British people.

The Sultan, who appears to have been a pliable tool in the hands of English Envoys, issued an order abolishing the system of compulsory labor, and disbanding all the fellahs employed by the company.

This arbitrary and unjust interference had but one meaning, and seemed likely to have but one result. The plea of humanity, advanced by a Government which had overlooked the sacrifice of 1000 men in one day, when that sacrifice had been made by their own injudicious advice, and for their own benefit, could be nothing more than a manifest subterfuge.

This vigorous handling of the political puppets on the diplomatic chess-board proved how serious were Lord Palmerston's apprehensions. It was the old question which every age revives. In the past, the issue had again and again been brought to the arbitrament of the sword. With such antagonists as Palmerston on one side and de Lesseps and the Silent Emperor upon the other, the duel was necessarily *ā l'outrance.*

It was now evident that war alone could arrest the completion of the maritime highway between the two seas. Was it the death of Palmerston or the progress of peaceful arts that kept this question confined to the field of diplomacy?

Opposition only stimulated the energy and confirmed the determination of de Lesseps. The controversy was referred to the decision of the French Emperor. A smile, half machiavelian, must have flitted over the face of his reticent Majesty when the question was submitted to his Imperial arbitration. By his decision the Egyptian Government were called on to pay, not unwillingly, an indemnity to the company for a release from the obligation to furnish compulsory labor, and for the retrocession of certain land grants and privileges of navigation.

"The indomitable Lesseps did not despair." After months of delay, he collected laborers from all parts of Europe, and the work was resumed.

The vigilance of the English opposition soon found another vulnerable point. The Sultan was again persuaded to issue a firman denying the right of the Viceroy to cede the land through which the canal was to be excavated. This well-aimed blow caused a suspension of operations for two years. Any man less able, self-reliant, or resolute than M. de Lesseps would have succumbed.*

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* For more detailed account of the difficulties and of the preliminary work, the reader is referred to the pamphlets of Capt. Methven, Pen. and Oriental Steamship Company; of J. N. Strouse, U. S. N.; Mr. H. Mitchell, Coast Survey; Blackwood, Dec., 1869, and other periodicals.

The Emperor was induced to intervene. M. Thouvenel, the French Minister at Constantinople, was requested "to enlighten the mind of the Sublime Porte as to the views and wishes of France."

The introduction of machinery now became a matter of necessity. Ten millions of dollars were expended for this object, and forty enormous dredges were soon at work upon the excavations. One of the novelties in the construction of these machines was a provision for carrying off the excavated material by means of a stream of water. One of the workmen, it is said, noticed that when removed in this way the slimy earth spread over a wide surface and became soon indurated, instead of flowing back into the place of excavation. It also possessed the further advantage of fixing the mobile sand.

The total amount of earth removed amounted to about four hundred million cubic yards. By working day and night, the machines of M. Borel and Lavelley were able to remove 78,056 to 108,000 cubic meters per month.

Although the completion of the canal now seemed assured, the opposition of the English Government continued up to the last moment. Every effort was made to prejudice the Sultan and the Khédivé against the work, and, by exciting the jealousy of the Sultan, to induce him to arrest the excavations.

After ten years of labor, this great work was completed. Upon the 17th of November, 1869, the opening of the canal was inaugurated in the presence of the Empress Eugenie and the Emperor of Austria, and of princes, embassadors, and men of science from Europe and America.

The Empress, leading the van of the fleet in her steam yacht, l'Aigle, entered the canal amid salvos of artillery. The yards of the ships were manned with sailors, every mast-head was decked with a flag, and the bands played the martial airs of the assembled nations. The transit between the two seas was safely made by the fleet. But the requisite depth had not been attained. Seventeen and a half feet could be carried through the canal. Since then the depth has been increased to twenty-two feet, and ultimately will be twenty-six feet.

The length of the canal is one hundred miles. The established surface-width is about 328 feet, except in difficult cuttings, where it is 190 feet. The least bottom width is 72 feet. The highest ground cut through is at El Guisr, where it is 85 feet; at Serapeum it is 62 feet; and at Chalouf, near Suez, it is 56 feet.

The excavation of the canal, although of considerable difficulty, was exceeded by the necessity for creating artificial harbors at the extremities. The harbor at Port Said, upon the Mediterranean, has

the general form of a triangle, the base resting on the shore and the longer side on the west, protecting the entrance from the moving sand. The longer arm, or mole, is 8,200 feet, extending to the 26 feet curve of sounding. It is proposed to extend this mole 2,300 feet farther. As this harbor is exposed to N. E. winds, an inside basin has been constructed. The area of the outer harbor is equal to 400 acres, and will permit twenty line-of-battle ships to swing freely at anchor.

At the other extremity of the canal, a mole 2,550 feet in length protects the channel, which has been dredged to the depth of 27 feet. The mole at Suez differs from that at Port Said in construction; the latter being formed of concrete blocks of 13 cubic feet, the former of stone quarried from the neighboring mountain.

The organization, equipment, sanitary regulations, and division of labor among twenty thousand men, employed at one time, is full of interest and instruction, but must be omitted in this place.*

The following statement of receipts and expenditures, taken from a recent periodical, deserves preservation:

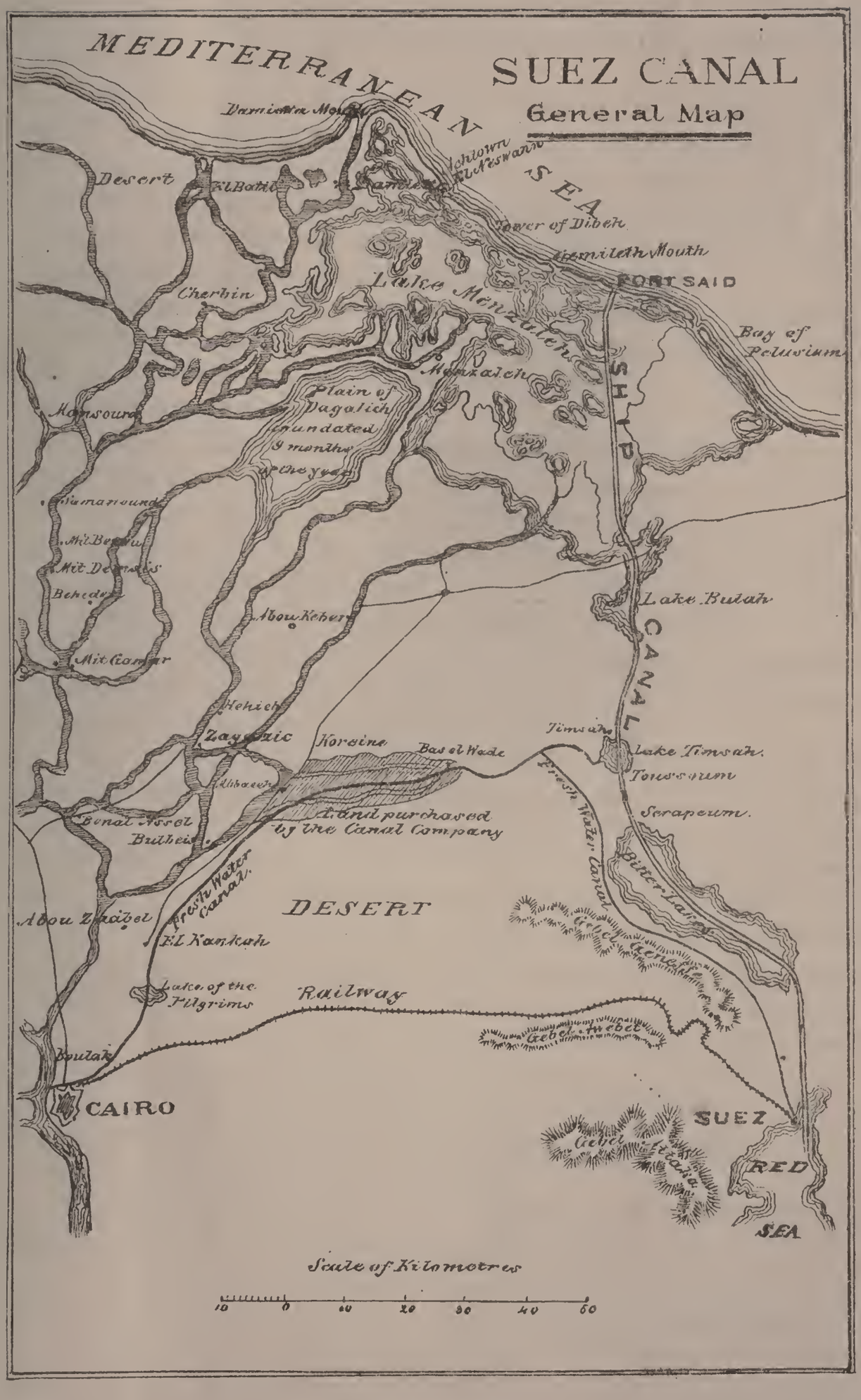
Gross Realized Capital.

Shareholders' capital	$40,000,000
Sale of bonds	19,999,980
Egyptian convention	5,948,805
Imperial arbitration	16,800,000
Rates of exchange	1,294,260
Various receipts received by the company	6,288,180
Total capital	$90,331,225

The following is a summary of the expenditures up to the date of the opening of the canal:

General expenditures for preliminary surveys from 1854 to 1859	$15,825,525
General expenses of administration and negotiations between France and Egypt	3,394,245
Sanitary service, 1866—1869	121,410
Telegraph service	34,000
Transport service, boats, stock, buildings	1,644,435
Payment of contractors for material	3,442,785
Dredging machines and heavy plant	6,819,240
Work-shops	844,150
Works of construction, canal, and ports	43,534,330
Miscellaneous	1,392,495
Expenses of various branches of company management	3,841,050
	$80,893,665
The average cost of the canal per mile is	$808,936

* The reader is referred to the reports of the French engineers; to the pamphlet of J. N. Nourse, U. S. N.; Blackwood, Dec., 1869; London Times, and other periodicals.


SUEZ CANAL
General Map
MEDITERRANEAN SEA
Damietta Mouth
Lake Menzaleh
Tower of Diben
Ismailieh
Mouth
PORT SAID
Bay of Pelusium
Cherbin
Desert
El Balah
Menzaleh
Plain of Pagalich
inundated
9 months
of the year
Mansoura
Samanoud
Mit Dessis
Behidet
Abou Keber
Mit Gamar
Hehieh
Zagazaic
Korsine
Bas el Wade
Timsah
Lake Timsah
Tousoum
Seraperum
Lake Bulah
SHIP CANAL
Land purchased
by the Canal Company
Fresh Water Canal
Bitter Lakes
Benal Assel
Bulbeis
Abou Zabel
El Kantara
DESERT
Lake of the
Pilgrims
Railway
Gebel Geneffe
Gebel Ataka
Boulak
CAIRO
SUEZ
RED
SEA
Scale of Kilometres
10 0 10 20 30 40 60

The balance on hand for the completion of the dredging is $9,437,560. This sum will probably be sufficient to excavate the canal to the uniform depth of 26 feet.

The effect of the opening of the canal is felt in the revival of maritime interests in the Levantine ports. Port Said is the depot of seven companies, Russian, French, and Austrian. A Spanish company is organizing with the intention of establishing a line between Barcelona and the Philippine Islands, and an American company is preparing a depot in the Mediterranean.

In 1869, thirteen hundred and sixty-two ships, amounting to 637,440 tons, entered Port Said. M. de Lesseps estimates that the annual revenue from tolls on the tonnage passing through the canal will be $12,000,000.

The canal has conquered a peace. Its enemies have become its most sanguine friends. The benefits it is destined to confer upon the commerce of the world, and the changes in the present commercial equilibrium of Europe, although important in their influence and immediate in their effects, must be proportionate to the duration of the canal as a highway for the commerce of the world.

The circumstances affecting the permanence of the canal have been so ably canvassed, that, apart from the intrinsic importance of the question, they deserve attentive consideration.

The ancient Pharaonic canal connected the Nile with the Red Sea, and partly avoided the destruction threatened by the unceasing advance of the sand dunes. The absence of harbors on the Mediterranean was compensated by the channel of the Nile, which afforded a passage over the bar for the light draft ships of that period. The French engineers, confident in the resources of modern science, have boldly conquered the difficulties which Egyptian engineers dared not encounter. It is well known that the distinguished engineer, Robert Stephenson, pronounced the work impracticable, and many cautious investigators have doubted its permanence.

The objections may be classed under two heads:

1. To the permanency of the excavation of the canal.

2. To the permanency of the harbors.

The arguments relating to the duration of the canal are drawn from history and the observations of travelers.

"We can not approach history," says M. de Lesseps, "without touching on Suez." Its records, fragmentary and uncertain, are hid in the mists of five thousand centuries. The stream of its history, now lost, now re-appearing, is joined in its course by the tributary traditions of nearly all the Indo-Germanic and Semitic nations. The

tramp of armies and the desolation of conquest has alternated with periods of intense activity in the arts, sciences, literature, and commerce. The Egyptian name, once a synonym of the profoundest learning, is now only known to us by an architecture which is still invested with a unique and imposing grandeur.

The value of a canal to afford transportation for the products of the East occupied the attention of the Pharaohs at an early date. Since the time of Rameses II, it has been repeatedly reconstructed and repaired. This Pharaoh, who lived about the period of the Mosaic exodus (1400 B. C.), was probably the Sesostris of Aristotle, Strabo, and Pliny.

If the Sesostus of the 12th dynasty was the constructor of the canal, its date would be carried back 2730 B. C. Its construction has also been attributed to other Egyptian rulers, but with more certainty to Nechao, B. C. 625.

Sir G. Wilkinson accounts for this uncertainty by a very plausible explanation. The sandy site of the canal required frequent excavation. These operations gave to successive kings the credit of having commenced the work which they only repaired.

The canal used by the Romans was afterward closed, and subsequently re-opened by the Caliph Omar. It was again closed for 134 years, when it was once more rendered navigable by El Hakim, A. D. 1000. It appears at this period to have extended to the Bitter Lakes before turning toward the Nile.

It again became filled with sand between the Nile and the Bitter Lakes. Mohammed Ali closed it entirely, after having lost 10,000 men from hunger, having hurried them into the desert without suitable preparation. At a more recent period, 1000 men died in one day from the same want of preparation, having been hurried into the desert, at the request of the English authorities, to work on the railroad between Suez and Cairo.

Pliny affirms that the ancient canal had a width of 100 feet and a depth of 40 feet as far as the Bitter Lakes, and the geological evidences indicate that the Bitter Lakes were once connected with the Red Sea. A stratum of salt, 8 to 10 feet thick, covers the bottom of the Lakes, and sea-shells are found in them and between them and Suez.

History for 3300 years bears testimony to the constant movement of the sand, burying all obstructions and obliterating channels which have lain in its path; and the statement of Herodotus, that Lower Egypt is a gift of the Nile, is sustained by a large number of scientific investigators, who maintain that ancient and modern Egypt was

reclaimed from an arm of the sea. When nature acts so constantly and irresistibly in one direction, the difficulties of those who contend with her can hardly be overstated.

The winds of Libya, sweeping over the desert, bear the sands irresistibly before them. The ruins of Isamboul and Palmyra are partly buried or threatened by the sand waves. The base of the great Pyramids are concealed, and the gigantic head of Memnon and Spynx are partially engulfed. The sand dunes near Ismaïlia move at the rate of ninety-eight feet per annum.

The following excellent description of the sand dunes is taken from Mr. Mitchell's report: "In the central part of the land of Goshen, where there are broad plains covered with flints, solitary dunes are seen, like golden islands, and they are objects of grace and beauty in every detail. On near approach to one of them, the sands may be seen traveling up the long rear slope before the wind, flying in the air at the crest, and falling down the fore slope in a perpetual cascade—every-where in motion, but preserving always the same faultless curves. Nor do these dunes leave a grain behind them to mark their tracks. The homogeneous sands of which they are composed are as fine as those usually seen in an hour-glass, and, like the latter, serve to measure the lapse of time in their steady march. The prevailing winds in this part of the desert blow from due north, and are more steady than at Port Said or Suez. In consequence of this, the course of the dunes is so nearly parallel to that of the canal, that their slow approach can always be prepared for. They can at any time be fixed by covering them with brushwood."

Between Lake Timseh and Port Said, it is estimated that 130,000 cubic yards of sand will be swept into the canal annually. This will give employment for one of the largest dredges for three or four months, working twelve hours each day. This estimate is based on the work done by one of Lavalley's first-class dredges, which removed 120,000 cubic yards per month, working day and night. But as the material will be distributed in a thin stratum along the entire length of this section of the canal, a longer period will be requisite for its removal. The able engineers who conducted the operations of excavation express confidence in their ability to keep the depth from decreasing. The chief danger from this source, therefore, can only come from a suspension of the work of the dredges.

2. Permanence of the harbors, particularly that of Port Said.

The reports of Capt. Spratt, Royal Navy, and of Mr. Mitchell, U. S. Coast Survey, supply very interesting information on this subject. M. Lartet is now publishing, in the *Annales des Sciences*

Geologiques, his observations upon the Isthmus. From the map of M. Lartet it appears that an arm of the Gulf of Suez once extended, by the way of the Bitter Lakes, to the Mediterranean, and that, at the same time, the Gulf of Akaba united the waters of the Red Sea and the Dead Sea. The endogenous movement which raised the mountains of Gebel Attaka and the crystalline rocks surrounding the north end of the Red Sea, placed the first barrier between the seas, and, by a succession of seismic movements, raised the cretaceous plateau of Egypt and Syria, or Palestine.

The mouth of the Nile at this period must have emptied into the Mediterranean, near the great Pyramid of Gizah ; and here the river must have begun to lay the foundation of modern Egypt along the border of the cretaceous formation.

Thus the geological record is in harmony with the traditions of the Priests as handed down to us by Herodotus, "Egypt is a gift of the Nile." Within historic times, the elevating movement has been inappreciable. The Nile still continues to roll down its plenteous bounty of sand, and to spread unceasingly its desolating influence over the plains of Suez and along the coast of Egypt as far as Syria.

Capt. Pratt, in the Medina, made a careful survey of the coast, sounding and dredging with sufficient minuteness to determine the limit of Nile influence. Within this limit, the bottom was found to be composed of siliceous sands, differing in no respect from the sands of the desert about the Pyramids. Outside of the Nile sand, the bottom of the sea was found to be composed exclusively of calcarious particles. The suspended matter, which is greatest during the Nile floods, driven eastward along the coast, accumulates upon the beach in the form of dunes, and overwhelms the huts of the coast guard and the fishermen, and, in twelve months, nearly buried the Mosque of Brulos. Commencing its devastating march, it advances irresistibly toward Suez.

The Nile brings down a prodigious quantity of sand, which is swept into the river by the Libyan winds, and borne by the current to the sea, mingled with fragments of pottery from the villages on the banks. The quantity of sand brought into the sea has excited the astonishment of the most experienced students of delta formations. The Ganges, the Indus, the Dneipper, the Danube, and the Mississippi, the Yang-Tse-Kiang, and the Hoang Ho bring down annually millions of tons of solid matter to add to the accretions at their mouths.

The whole amount carried yearly into the Gulf of Mexico by all


GEOLOGICAL MAP
OF
PALESTINE AND LOWER EGYPT
MEDITERRANEAN SEA
BEYRUT
CARMEL
JOPPA
ALEXANDRIA
Mouths of the Nile
DESERT OF LIBYA
EGYPT
PALESTINE
DEAD SEA
HAURAN
TYH
ARABIA
SINAI
RED SEA
ASSOUAN
Volcanic Rocks
Post-Tertiary & Recent
Miocene
Cretaceous and Nummulitic Limestone
Sandstone of Nubia
Crystalline Rocks

the passes of the Mississippi is seven hundred and fifty millions of cubic feet, or a mass of one mile square and twenty-seven feet thick. "As the cubical contents of the whole mass of the bar at the South-west pass is equal to a solid of one mile square and four hundred and ninety feet thick, it would require fifty-five years to form the bar as it now exists." *

Since the time of Strabo the Nile has advanced the coast line of Egypt, by its yearly contributions of sand, from four to six miles into the sea. Any interruptions of the littoral currents greatly accelerates this result. Such is the well-known effect of jetties and moles. Since the construction of the mole at Port Said, the shore line has advanced 1213 feet in eight years. Eighty-eight feet of this distance was made in the last six months. "If the shore line continues to advance," Mr. Mitchell remarks, "at any thing like its present rate, the dry land will extend to the end of the mole in forty years. The shoaling of the entrance to the harbor will keep pace with the advance of the shore line, and before the end of twenty years an extension of the mole will be necessary."

The silting up of the interior of the harbor by the sand which sifts through the interstices of the concrete block is regarded by Mr. Mitchell as a more serious evil. But as it may not be impracticable to close these interstices, this danger does not seem comparable to that which must arise from the unceasing eastward movement of the sands brought down by the Nile. It was for this reason that Alexander placed his city to the west of the mouth of the Nile.

The boldness and skill displayed in the construction of the harbor of Port Said may be appreciated from these facts. The excavation of the canal presented comparatively little difficulty. The entire cost of the canal and harbors was about forty-three and a half millions of dollars, or more than half of the entire cost of the work, which includes the expenses of hospitals, negotiations, surveys, machinery, and the miscellaneous expenses of administration, amounting in the aggregate to $80,893,665.

The doubts of the permanent value of the Suez Canal, as expressed by Lord Palmerston and Sir Robert Stephenson, do not appear to have been without sound and reasonable foundation. It is evident that a few years of war will, as in the days of the Pharaohs, Ptolemies, the Cæsars, and the Caliphs, necessitate a reconstruction on a scale almost as great as that which has recently challenged the admiration of the civilized world.

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* See Delta Report of Generals Humphreys and Abbot.

It is unnecessary to say any thing of the harbor of Suez. The difficulties encountered at this point were much more easily conquered than at Port Said.

The Egyptian Government has provided excellent docks and every facility for the repairing of ships at the southern terminus.

CHAPTER II.

Influence of Commerce—Distances Reduced by the Suez Canal—Tables showing the Gain of the United States and European Ports—Navigation by way of Red Sea and Good Hope—Napoleon III on Advantages of the American Route—Darien and Suez Canals as parts of one system of Navigation—Lieut. Maury on Darien Canal; its influence on the Resources of the Basin of the Mississippi—Table of Distances by Cape and Canal—Saving to the Commerce of the World—Table showing how far the great Maritime States are interested in the American Canal—Advantages of Suez and Darien Canals.

STATISTICS have been accumulated to show to what extent commerce will be benefited by the Suez Canal. The question of choice of route is not dependent on distance alone. The winds and currents are natural advantages or dangers which the navigator skillfully avoids or employs. Steam, while it enables a vessel to contend with wind and current, is yet obliged to obey their dictates. The distance of coaling stations, the large space occupied by fuel to the exclusion of freight, renders steam desirable rather as an auxiliary than as the sole means of propulsion.

The Suez Canal has reduced the distances from European ports to India about one-half. England derives an equal advantage, yet she has justly regarded with apprehension the diversion of trade from the old route. Anticipating the day when she would be compelled to acquiesce in the opening of the new highway, she has shrewdly secured the military command of the new course of trade which threatens her monopoly.

For the United States, the distances to the East are reduced to from 2000 to 4000 miles. But on account of winds and currents for homeward-bound ships, the old route by way of Cape Horn is still preferable.

The following table, computed by M. de Lesseps, exhibits the distances from European and American ports to Bombay:

PORTS.	BY CAPE HORN.	BY SUEZ CANAL.	SAVING EFFECTED BY CANAL.
	MILES.	MILES.	MILES.
Constantinople	14,760	4,350	10,410
Malta	14,130	4,990	9,140
Trieste	14,420	5,660	8,760
Marseilles	13,675	5,745	7,930
Cadiz	12,584	5,384	7,200
Lisbon	12,960	6,050	6,910
Bordeaux	13,670	6,770	6,900
Havre	14,030	6,830	7,200
London	14,400	7,500	6,900
Liverpool	14,280	7,380	6,900
Amsterdam	14,400	7,500	6,900
St. Petersburg	15,850	8,950	6,900
New York	15,000	9,100	5,900
New Orleans	15,600	9,000	6,600

The subjoined table contains distances from London, New York, and Port Royal to certain Eastern ports, compared with distances to the same ports from New York via the Pacific Railroad and Darien:

ORIENTAL PORTS.	LONDON, VIA SUEZ.	NEW YORK, VIA SUEZ.	PORT ROYAL, VIA SUEZ.	NEW YORK, VIA PAC. R. R.	NEW YORK, VIA DARIEN.
	MILES.	MILES.	MILES.	MILES.	MILES.
Melbourne	11,280	13,200	13,700	10,300	10,400
Shanghai	11,504	12,500	13,000	8,850	11,100
Hong Kong	10,469	11,700	11,100	9,300	10,850
Manila	9,639	11,600	12,200	9,600	11,500
Singapore	8,239	10,300	10,800	10,600	12,800*
Batavia	.....	10,500	11,000	11,000	12,550
Penang	7,859	9,950	10,430	11,000	12,800
Calcutta	7,964	9,700	12,200	12,150	14,350
Ceylon	7,946	8,750	9,250	12,200	14,300
Yeddo	.....	.....	.....	.....	10,200
Bombay	.....	9,000	.....	.....	.....
Yokohama	.....	11,504	.....	.....	.....

According to the first table, distances from the European and American ports therein named are shortened one-half. According to the second table, the distances to Oriental ports, from the great European and American entrepōts, are greater by the Darien route;

* 17,738 miles during S. W. monsoon. For a part of this table I am indebted to Com. B. F. Sands, U. S. N.

but by reason of winds and currents, the voyage by the way of Suez is from four to five days longer.

In the Red Sea the prevailing winds are from the north, which retard the steamers and compel the sailing ships to beat up to Suez. "From Suez to Ceylon," according to the *London Times*, "the winds are unfavorable. From Point de Galle to Swan River, terrible hurricanes sweep the Indian Ocean. Along the coast of New South Wales, violent winds prevail from the westward, causing a prodigious sea to arise, which nearly precludes navigation in that direction."

The route by way of Good Hope is beset by gales from the south-west and north-west, rendering the return passage a matter of great uncertainty; but by Darien or Panama route, going or returning, regular voyages and smooth seas may be counted on with precision.

For steam, but more especially for sailing vessels, the American route, lying in the zone of the trade-winds, possesses special advantages. Outgoing and returning ships may trim their sails to favorable winds; and the experienced navigator may have the aid of confluent currents, and enter the monsoons at greater advantage.

Napoleon III, when a prisoner in Ham, thoroughly examined the advantages of the American route. "In regard to the United States of America," he observes, "all the distances would be shortened 1400 miles and fifteen days"——"Europe would gain forty-seven days in a voyage to the coast of South America, while the United States would gain sixty-two days. To China and Sidney, Europe would gain twenty-nine days, and the United States twenty-four days."

But it is not as rivals that the two routes should be compared, but as parts of the same system by which maritime nations are brought into commercial union. The benefit which each route will confer upon commerce is doubled by considering the effects of both together. The one opens the gates to the East, the other to the West. While one route is favorable to outward ships, the other affords equal advantages to the homeward bound, so that in many cases the most desirable route would lead to a circumnavigation of the globe.

To appreciate the importance of such a system of navigation, and exhibit some of the advantages of the American route, it may be well to compare it with the old route, by the way of the Cape, which will still remain the principal highway to the East.

"The Englishman," says Lieut. Maury, "meets the American in all the markets of the world with the advantage of ten days or up-

ward. Cut through the Isthmus, and instead of some ten days' sail or more, the scale would be turned, and we shall have the advantage of some twenty days' sail, thus making a difference of thirty or forty days under canvas." The distance between New York, China, India, and Australia, and the west coast of South America exceeds that by way of Cape Horn from 8,000 to 14,000 miles.

To the States lying in the great basin of the Mississippi, and to all the cities situated on its navigable waters, the gain is much greater. These parts of the continent, now secluded by their position from direct trade with the west coast of South America and the Indies, will be brought into closer commercial relations with these ports of the world. With but one transhipment, the silk, teas, spices, and fabrics of India, China, Japan, and the Pacific Islands may be landed on the banks of the Mississippi, Missouri, and Ohio.

The following tables, taken from the Report of Lieut. Maury to the Committee on Naval Affairs, will show the sailing distance from New York and Liverpool to the principal ports beyond and around Cape Horn and the Cape of Good Hope. The distances to South and North Pacific ports are greatly reduced by the Darien or Panama route·

	FROM LIVERPOOL.	FROM NEW YORK.
	MILES.	MILES.
To Calcutta, via Cape of Good Hope	16,000	17,500
Calcutta, via Cape Horn	21,500	23,000
Canton, via Cape Horn	20,000	21,500
Canton, via Cape of Good Hope	18,000	19,500
Valparaiso, via Cape Horn	11,400	12,900
Callao, via Cape Horn	12,000	13,500
Guayaquil, via Cape Horn	12,800	14,300
Panama, via Cape Horn	14,500	16,000
San Blas, via Cape Horn	16,300	17,800
Mazatlan, via Cape Horn	16,500	18,000
San Diego, via Cape Horn	17,000	18,500
San Francisco, via Cape Horn	17,500	19,000

The following table shows the saving of time from New York by the new route, via the Isthmus of Panama, as compared with the old routes, via Cape Horn and Cape of Good Hope, to the places therein named, estimating the distance which a common trading ship will sail per day to be one hundred and ten miles, and calculating for the voyage out and home:

FROM N. Y. TO	DISTANCE VIA CAPE OF GOOD HOPE.	LENGTH OF PASSAGE OUT AND HOME.	DISTANCE VIA CAPE HORN.	LENGTH OF PASSAGE OUT AND HOME.	DISTANCE VIA THE ISTHMUS OF PANAMA.	LENGTH OF PASSAGE OUT AND HOME.	SAVING IN DISTANCE OVER THE ROUTE BY CAPE OF GOOD HOPE.	TIME SAVED BY ISTHMUS OVER TIME BY CAPE HOPE, OUT AND HOME.	SAVING IN DISTANCE OVER THE ROUTE BY CAPE HORN.	TIME SAVED BY ISTHMUS OVER TIME BY CAPE HOPE, OUT AND HOME.
	MILES	DAYS	MILES	DAYS	MILES	DAYS	MILES	DAYS	MILES	DAYS
Calcutta	17,500	318	23,000	418	13,400	244	4,100	74	9,600	174
Canton	19,500	354	21,500	390	10,600	192	8,900	162	10,900	198
Shanghai	20,000	362	22,000	400	10,400	188	9,600	174	11,600	212
Valparaiso	.....	.....	12,900	234	4,800	86	.....	.....	8,100	148
Callao	.....	.....	13,500	244	3,500	62	.....	.....	10,000	182
Guayaquil	.....	.....	14,300	260	2,800	50	.....	.....	11,500	210
Panama	.....	.....	16,000	290	2,000	36	.....	.....	14,000	254
San Blas	.....	.....	17,800	322	3,800	68	.....	.....	14,000	254
Mazatlan	.....	.....	18,000	326	4,000	72	.....	.....	14,000	254
San Diego	.....	.....	18,500	336	4,500	82	.....	.....	14,000	254
San Francisco	.....	.....	19,000	344	5,000	90	.....	.....	14,000	254
Wellington, N. Z.	13,740	.....	11,100	.....	8,480	.....	5,260	.....	2,620	.....
Melbourne, Australia	13,230	.....	12,720	.....	9,890	.....	3,340	.....	2,830	.....

The following condensed statement, from tables carefully prepared by an advocate of intermarine canals, exhibits some of the commercial advantages depending upon the completion of the route:

Table showing the saving to the trade of the world, in insurance on vessels and cargoes, interest on cargoes, saving of wear and tear of ships, and saving of wages, provisions, etc., by using the Isthmus Canal:

United States	$35,995,930
England	9,950,348
France	2,183,930
Other countries	1,400,000
Total yearly saving	$49,530,208

Exports of Great Britain increased one hundred and seven per cent. in ten years; exports of France increased one hundred and thirty per cent. in ten years; exports of the United States increased ninety-three per cent. in ten years. If the trade increases one hundred per cent. in the next ten years, the saving to the world will then be ninety-nine millions sixty thousand four hundred and sixteen dollars ($99,060,416) per annum.

Taking this statement as a basis, and representing the gross pecuniary interest of the United States in the proposed canal as unity, the saving to Great Britain will be one-fourth, to France one-eighteenth, and to all other countries one-thirty-fifth.

This preponderance of interest on the part of the United States may be taken to imply a proportionate share in the cost. Such would be a correct conclusion if our Government retained control of the route. Surrendering the latter claim, she relinquishes with it her proportionate liability, and is entitled to be received as one of the contracting parties upon terms of equality. The respective shares of the parties is, however, a proper subject for diplomatic arrangement. But while the greatest saving accrues to the United States, the absolute value of our oriental exports and imports is about equal to that of Great Britain, and about double that of France and other countries.

Neutralization of the Isthmus is only, in appearance, a suspension of the policy understood as the Monroe Doctrine. It can be made an international recognition of that policy. Such objections, even if well founded, sink into insignificance in comparison with the benefits which must accrue to mankind at large. The United States has not shown herself so incapable of adopting a policy in accordance with her high destiny, as to justify a suspicion that she will ever by her acts sanction the selfish theory that "nations may combine to oppress and plunder, but rarely for any useful or benevolent purpose." The progress of events has already made her an arbiter in the destiny of nations, and she can no longer, by an insular and anti-social policy, separate herself from the interests of the great family of nations. Mutual and liberal concessions in the generous spirit of our civilization, looking to the extension of commerce, industry, arts, science, and religion throughout the world, can alone lead to that harmonious coöperation without which an interoceanic ship canal must remain forever problematical.

The above tables supply material for other important conclusions. Eighteen vessels, sailing from as many different ports in East India, China, Japan, Australia, and South America, would save the average distance of 8,791 miles, equivalent to a voyage by sail of about eighty days, or to between thirty-six and forty days by steam.

Supposing the average tonnage of ships to be one thousand tons, then three thousand and ninety-four steamships would be requisite to carry the freight which would now seek the Isthmus annually. The saving of time to trade and to each man would be about three and four-tenths years to every generation of thirty-three years. The amount of tonnage above mentioned would give employment to 86,632 seamen, giving to them, by the new route, a saving of time in one generation amounting to the aggregate of 294,548 years. The benefits being diffused among all engaged or interested, directly or indi-

rectly, the accession to the time, wealth, and industry of so large a number of men is not only a great economic and commercial advantage, but may be regarded as participating in the nature of those beneficent, moral movements which characterize the age.

The annual saving to the trade of the world is shown to be $49,530,208.00. The annual increase of the trade of Great Britain, France, and the United States is together more than one hundred per cent. The saving to the maritime powers in one year at the end of a decade will be $99,060,416.00. Assuming the trade of the three powers to increase in the same ratio, the total amount saved at the end of ten years will be equal to the aggregate of the amounts saved each year, and foots up as follows:

Amount saved at end of first year	$54,483,228.80
" " " second year	59,436,249.60
" " " third year	64,389,270.40
" " " fourth year	69,342,291.20
" " " fifth year	74,295,312.00
" " " sixth year	79,248,332.80
" " " seventh year	84,201,353.60
" " " eighth year	89,154,374.40
" " " ninth year	94,107,395.20
" " " tenth year	99,060,416.10
Entire amount saved in ten years	$767,718,224.10

This result is verified by an estimate based upon the tonnage which will be actually engaged in this trade:

Maintenance of ship and crew of 1000 tons	$500	per month.
Interest of 1½ per cent. on tonnage worth $17,000.	255	"
Insurance at 1 per cent. on value of ship worth $18,000	180	"
Saving per month	$935	
Add reduction of insurance upon ship and cargo at 1 per cent	350	
Total saving per month	$1285	

The annual saving for each ship will be $15,420, giving as the aggregate saved upon the tonnage which would pass the Isthmus the sum of $47,709,480, and the saving of one year at the end of a decade as $95,418,960, a sum sufficiently near the first to establish its correctness.

The following tables were compiled by Mr. F. W. Kelley, of New York, and were intended to exhibit the effect upon the trade of the world by the completion of the canal through the Isthmus:

Table showing the trade of the U. S. that would pass through the Isthmus Canal, if now finished. Taken from the official returns for 1857.

COUNTRIES TRADED WITH	EXPORTS AND IMPORTS.	TONNAGE.
Russian North American Possessions	$ 126,537	$ 5,735
Dutch East Indies	904,550	16,589
British Australia and New Zealand	4,728,083	52,105
British East Indies	11,744,151	177,121
French East Indies	98,432	3,665
Half of Mexico	9,601,063	34,673
Half of New Grenada	5,375,354	131,708
Central America	425,081	36,599
Chili	6,645,634	63,749
Peru	716,679	193,131
Equador	48,979	1,979
Sandwich Islands	1,151,849	33,876
China	12,752,062	123,578
Other ports in Asia and Pacific	80,143	4,549
Whale fisheries	10,796,090	116,730
California to East United States	35,000,000	861,698
Value of cargoes	$100,294,687	$ 1,857,485
Value of ships, at $50 per ton	92,874,250	.....
Total value of ships and cargoes	$193,168,937	$ 92,874,250

"Whale ships and coasting vessels have been estimated generally throughout this appendix at forty dollars ($40) per ton. The United States and European commerce around the Capes is conducted in first-class ships, which often cost eighty dollars ($80) per ton. Fifty dollars ($50) have therefore been taken as the fair average value in the construction of this table, which does not include coasting trade."

Table showing the trade of England that would pass through the Isthmus Canal, if now finished. Taken from the official returns for 1856

COUNTRIES TRADED WITH.	EXPORTS AND IMPORTS.	TONNAGE.
Half of Mexico	$ 2,775,137	$ 11,833
Half of Central America	1,244,817	5,615
Half of New Grenada	2,437,605	10,188
Chili	15,486,110	118,311
Peru	20,473,520	244,319
Equador	360,015	1,820
China — Outward; only 40 days saved by the canal	7,077,390	68,530
Java — Outward; only 40 days saved by the canal	3,821,410	16,003
Singapore — Outward; only 40 days saved by the canal	4,364,070	16,500
Australia and New Zealand	78,246,095	522,426
Sandwich Islands	520,560	1,950
California	2,378,105	11,800
Value of trade	$139,184,834	$ 1,029,295
Value of ships, at $50 per ton	51,464,750	.....
Total value of trade and ships	$190,649,584	$ 51,464,750

Table showing the trade of France that would pass through the Isthmus Canal, if now finished. Taken from the official returns for 1857.

COUNTRIES TRADED WITH.	EXPORTS AND IMPORTS.	TONNAGE.
Chili	$ 10,000,000	$ 25,688
Peru	13,160,000	35,096
Half of Mexico	2,790,000	10,004
Half of New Grenada	1,090,000	2,389
Equador	440,000	1,651
Bolivia	100,000	1,000
California	2,073,859	8,997
China } Outward only	2,180,000	2,028
Dutch East Indies } Outward only	4,440,000	20,400
Sandwich Islands	2,000,000	4,119
Philippine Islands	1,000,000	1,463
Australia	19,800,000	50,000
Value of cargoes	$ 59,073,859	$ 162,735
Value of ships	8,136,750	at $50 per ton
Total value	$ 67,210,609	$ 8,136,750

The value of the tonnage which would take the Darien route is, according to the above table, $152,475,750, and the total value of exports and imports passing the same way is:

England	$193,168,939
United States	190,649,584
France	67,210,609
Total value of trade passing the Isthmus	$451,029,132

But the aggregate amount of British imports and exports from and to India and China is $378,587,122, giving the value of the trade which would pass through the Suez and Darien Canals $636,447,315, yearly.

The rapidly growing trade between Levantine ports and India would take the Suez route, but between the European ports and the Pacific coast of North and South America, and between the east and west coasts of these two continents, the American route would be exclusively employed.

In selecting a route to oriental ports it is evident, from the facts of physical geography, as stated by Lieut. Maury, Napoleon III, and the writer in the *London Times*, that the navigator seeking to make a rapid voyage would adopt the American route both going and returning, except, perhaps, between Levantine and Indian ports. Between French, English, Levantine, and Indian ports, the outward voyage by way of Darien, or Panama, and homeward by way of Suez would, in many cases, be favorable to the quickest trip.

The Suez Canal was built by French talent, French energy, French machinery, and French money. England and the Mediterranean States participate in the benefit. But the larger share of the profit belongs to France, by reason of her ports and industrial resources; and so far as France and the Levant enter into a direct trade with India, so far, it has been supposed, will the value of trade between Great Britain and India be impaired.

We have spoken of the piercement of the American Isthmus as an international work. It should rather be the work of American energy, American talent, and American money. It is part of the American continent. No foreign nation can have the same military control of it that Great Britain now has of the Suez Canal. The benefit of its construction, although shared by the maritime powers, will be most important to the Americas, and by reason of resources, organization, and position, especially to the United States. It deserves consideration as an American project.

CHAPTER III.

The Canal considered as an American Project exclusively—Currents and Winds—Resources of the Basins of the Rivers of the Gulf and Caribbean Sea—Their Productive Capacity compared with the Mediterranean Basins.

LET the reader refer to Berghaus's map of winds and currents, and any map of the alluvial basins of the river systems of Europe and America. He will observe that the Caribbean Sea and Gulf of Mexico constitute but one sea, partially divided by the West Indies and Cuba, which, stretching toward Yucatan, is separated from that part of Central America by a channel 100 miles wide and 6000 feet deep.

The equatorial current, crossing the ocean with the trade winds, enters the Caribbean Sea, and, passing between Cuba and Yucatan into the Gulf of Mexico, flows out through the Strait of Florida. Ships from the east following this current are led in the path of favorable winds, both going and returning.

The Pacific trade winds and equatorial current are equally favorable to the outward and homeward bound voyager. The skillful

navigator shapes his course north of the equatorial current when returning from China to San Francisco or Panama.

The Humboldt and Mexican currents aid the coastwise trade. Thus, by the converging winds and currents, this great intertropical sea seems to be designated by nature as the future commercial center of the world.

The two American seas have been styled by Lieut. Maury as the heart of the continent. Its two compartments have been compared to the auricle and ventricle of the human heart, through which, in regular pulsations, by unceasing systole and dyastole, the ocean currents find constant entrance and exit, and circulate through all the world-arteries their vivifying influence.

Pursuing the analogy, the two continents, from their general shape and the alimentary part they perform, may not inaptly be compared to the lungs, which convert the blood of commerce into the nutrient and productive elements which contribute to the health and growth of the nationalities of two continents.

The rivers having their natural outlet in the Caribbean Sea and the Gulf of Mexico, bring into commercial union two regions producing all the commodities of the globe. The rivers of North America bear to the Gulf the successive harvests of the temperate zone, and receive in return the fruits, woods, dyes, drugs, spices, coffee, cotton, and tobacco of intertropical America.

No part of the globe combines so many natural advantages as are found united around this body of water. Its shores present every advantage of soil, climate, vegetation, and convenient harbors likely to attract an enterprising and commercial people. The table lands of Mexico, Yucatan, Guatemala, Honduras, and Columbia afford the most salubrious climate, scenery of the rarest beauty and sublimity, equable temperature, and an endless succession of fruits and harvests. Mountains of perpetual snow look down on plains of unceasing verdure. All that is requisite for the support of life grows spontaneously.

The descriptions of Humboldt represent the table lands as suitable to the highest development of the race. One wonders that the tide of immigration, guided by the rational instinct for superior advantages, has not filled every bay and estuary and overspread the plains ; or, sweeping down from the north, the Anglo-Americans have not taken possession, as the hardy races of the North of Europe overran the degenerate mixture of nations which overspread the northern shores of the Mediterranean.

Those portions of the world which possess the finest climate,

whose soil returns the largest yield from the least amount of labor, are held by degenerate and effete representatives of a moribund civilization.

In America no alpine barrier interrupts communication with the interior, but an indefinite expanse of plains, prairies, and table lands stretch away to the north, or form broad plateau, as in Central and South America.

Millions of square miles of arable lands are intersected by rivers of unrivaled extent. The Mississippi, rising in such proximity to the northern lakes as to make their shores tributary to the trade of its valley, flows through twenty degrees of latitude before reaching the Gulf of Mexico. The Amazon, nearly at right-angles with the Mississippi, developing its course chiefly in longitude, bears the varied products of its valley to the ocean, where the equatorial current makes it tributary to the Caribbean Sea. The Amazon is more directly connected with this sea by the Orinoco, with which it is united by the Rio Negro. Humboldt surveyed the channel joining the two rivers, and ascertained the feasibility of a navigable channel between them at high water.

The different positions of the main commercial arteries of the two continents—the one extending through temperate latitudes, the other through tropical longitudes—supply the greatest variety of commodities for commercial interchange. The Mediterranean system, finding its most extensive development in longitude, is limited in the variety of its products by the climatic uniformity of one zone. While American rivers flow through twenty-five degrees of latitude, the European rivers of the Mediterranean extend through but ten degrees.

Berghaus's map supplies data for a comparison of the river system of the two great continent-bounded seas of the Eastern and Western Hemispheres:

	SQUARE MILES.
Area of the Mississippi basin, including the basins of its tributaries, the Missouri, Ohio, Arkansas, Red River, etc.	2,231,000
Rio del Norte	180,000
South American basins: Magdelina	72,000
South American basins: Orinoco	250,000
South American basins: Amazon	1,512,000
Entire area of basins which drain into the Gulf of Mexico and Caribbean Sea	4,245,000

Area of the Basins of the Mediterranean Systems of Rivers.

	SQUARE MILES.
European, Euxine, and Caspian	1,890,000
Basin of the Nile	520,000
Area of basins of the Mediterranean rivers	2,410,000

Area of basin of the river system of the Gulf of Mexico and the Caribbean Sea is 4,245,000 square miles, a productive area nearly double that of the Mediterranean, which it exceeds by 1,835,000 square miles.

In the extent of its navigable rivers, the difference is proportionately large. The Mississippi and its tributaries constitute a continuous channel for steam navigation of 12,000 miles in extent, which would be nearly doubled by reckoning the length of the navigable channels at the period of high water.

The river system of the Mediterranean, Euxine, and the Caspian, to which may be added that of the Nile, will not together exceed 5000 miles, or less than half the length of navigable channels of the American system.

The natural advantages of the Mediterranean of America may be summed up as follows: with double the productive area, it has capacity for a greater variety of products, by reason of its variety of climate; it has double the extent of navigable rivers, which pour their bounties into the same sea; and not only are the rivers and continents tributary to this region, but the ocean currents and winds, converging at the same point, bring the products of the Orient to exchange for those of the New World.

In a letter addressed to Mr. Rockwell, M. C., at that time secretary of the special committee to whom was referred a resolution of Congress, asking for information respecting routes to the Pacific, Lieut. Maury has, with signal ability and in not too glowing language, sketched the future of the American Mediterranean, (which is destined to surpass its European prototype,) whose fine harbors will become the marts of an opulent trade and the centers of a higher standard of civilization.

These desirable ends will be greatly accelerated by the intermarine canal between the two seas, by which the trade of China and Japan may meet the commodities of Europe—

> "Argosies of stately sails,
> Pilots of the purple twilight, dropping down with costly bales,"

and the products brought down by the Mississippi and the Amazon into the Gulf of Mexico.

CHAPTER IV.

Effect of the Canal on the Interest of the Valley of the Mississippi—Pacific Railroad as a Rival of the Isthmean Canal—Rates of Freight on Ocean, Lakes, Rivers, Canals, and Railroads—San Francisco and the Trade of China and Japan—Considerations of General Interest—Probable Revenue.

THE products of the Valley of the Mississippi and its tributaries may be collected at points along the river, to be shipped direct for China, Japan, Australia; and the products of the Orient may be brought, without breaking bulk, to Galveston, New Orleans, Mobile, Pensacola, Appalachicola, and even Memphis, Cairo, St. Louis, Louisville, and Cincinnati, thence to be distributed by the river system, which extends throughout the States of the South, and reaches even to the borders of British America. With one, or at most two, transhipments, the produce of the Indies may be transported, by the way of the Illinois river, or the projected improvement of the Fox and Wisconsin rivers, to Chicago and Lake Michigan, thence to be distributed throughout the shores of the northern lakes.

Teas, silks, Japanese and East India goods may be transported by way of the ship canal and the Mississippi river, and delivered at St. Louis at one-third or one-fourth the cost of transportation of the same articles by the Pacific railroad. While the Pacific railroad is a great national highway, bringing into political and commercial union two great sections of the country, building up cities, opening mines, bringing under cultivation a vast extent of arable land along its route, the proposed canal across the American Isthmus must be the sole dispenser of the bulkier products of China and the Indies.

The question may be asked how far the railroads constructed and to be constructed between the Atlantic and Pacific, especially within the limits of the United States of America, may supersede the commercial advantages which would result from the canalization of the Isthmus?

Trade has always increased in proportion to the facilities for transportation; and it is evident that, even in the most populous country, the reciprocal relation of production and consumption may be increased by a better organization and a more judicious application

of labor. In all cases of competition between railroads with canal, lake, or coast trade, the result has been the reduction of rates and the increase in the quantity of material transported. Two railroads, American and Canadian, skirt the shores of the Northern Lakes, making, with the line of lake steamers, three competing lines. The consequence of this rivalry has been a reduction upon freight during the summer months, to enable the two roads to compete with the lake route and canal.

To exhibit the relative cost of different methods of transportation, a statement is subjoined. The following table, compiled from different sources, exhibits the cost per ton per mile of transportation of freight upon the ocean, lakes, rivers, canals, and railroads:

TRANSPORTATION BY	PER TON PER MILE.	
	CENTS.	MILLS
Ocean—long voyage	.....	1
Ocean—short "	.....	2 to 4
Lakes—long " } U. S.	.....	2
Lakes—short " } U. S.	.....	3 to 4
St. Lawrence River	.....	3
Hudson River	.....	2½
Ohio River—long voyage	1	1.54
Ohio River—short "	1	3.6
Missouri River—long voyage	.....	8.37
Missouri River—short "	2	0.1
Mississippi River—long voyage	.....	5.07
Mississippi River—short "	.....	8.50
Erie Canal enlargement	.....	4
Railways transporting coal	1 to	6
Reading Railroad transporting coal	.....	9.71
Reading Railroad transporting merchandise	.....	4.468
Railways—ordinary grades	1	2½
Pacific Railroad { for transporting different kinds of freight. }	3	2.8
Pacific Railroad { for transporting different kinds of freight. }	6	0.6
Suez Canal—$2 per ton, transit of 100 miles	2	00
Proposed Panama Canal—$1 per ton, transit of 50 miles	1	00

The railroad rates above given have been established upon thoroughfares favorable for the attainment of a minimum. But upon all roads to be constructed between the Atlantic and Pacific, much higher rates must prevail for many years. Hurried construction, through a wilderness deficient in material and obstructed by hostile savages, must increase the cost of construction. For the same reason, the execution of the work is likely to be defective and the location of the route imperfect. The expense of alteration and repair must be proportionately increased. The cost of stations, machine shops, depots of fuel, and supply of water must far exceed the disbursements for the same objects in a settled country, pos-

sessing the advantages of skilled labor and convenient transportation.

To meet the additional expense, the rates for passengers and freights will have to be increased to probably six or eight times the value assigned for ordinary grades.

On the other hand, ocean transportation by way of the Isthmean Canal, collecting by tolls enough to pay the cost of repair—say one dollar per ton transit, or one cent per ton per mile for fifty miles—would be but one-fourth the average rate per ton per mile for the three thousand miles of transportation on the Pacific Railroad.

Passengers will always take the quickest route. Valuable packages of goods, gold, and silver, and even teas and small packages of costly silks, will be transported by the railroad. The Pacific coast and the interior country lying between the head of navigation of the tributaries of the Mississippi, will receive the commodities of the East chiefly through the port of San Francisco.

The following table shows the relative distances of San Francisco and London from Oriental ports:

ORIENTAL PORTS.	LONDON, VIA SUEZ.	SAN FRANCISCO DIRECT.	SAVING BY SAN FRANCISCO.	SAVING BY LONDON.
	MILES.	MILES.	MILES.	MILES.
Melbourne	11,281	7,902	3,379	.....
Yokohama	11,504	7,520	6,984	.....
Shanghai	10,469	5,555	4,914	.....
Hong Kong	9,669	6,355	3,314	.....
Manila	6,939	6,135	3,504	.....
Singapore	8,239	7,785	454	.....
Penang	7,856	8,165	.....	306
Calcutta	7,946	9,665	.....	1,719
Ceylon	8,646	9,378	.....	2,732

From the above table it is evident that England will have a formidable rival for the trade of the East in the Pacific ports, and the interior which they will be called on to supply.

It is manifest that an intermarine canal is not impracticable to American talent and energy. It can undoubtedly be executed by international coöperation. It is demanded by the common interest, commercial, political, and social, of all peoples. It is supported by humanitarian considerations, immediate in their influence, broad and practical in their relations to the interests of society.

The chief obstacle to its execution is its cost, which would be nearly double that of the Suez Canal. Mr. Kelly estimates that

3,090,000 tons would pass through the American canal yearly. Assuming that its total cost will be 150 millions of dollars, the revenue from tolls, at the rate of one cent per ton per mile, would amount to nearly twenty per cent. of the entire outlay.

No work, so costly nor fraught with such stupendous consequences, has ever been attempted by man. The history of civilization is the history of the efforts of man to assert the right and to increase the means of individual development. The monuments of science, skill, and industry, left by ancient nations to perpetuate the names and conquests of Kings and Pharaohs, were wrung by oppression from suffering men.

To us is left the opportunity for a more extended organization—a combined world movement—in the interest of science and religion, for the extension of liberty, and for the diffusion of civilization among the races of mankind.

Less than the cost of one year of war, will establish for all time—only to be shaken by a paroxysm of nature—this enduring monument of peace and good will, and will secure to the United States a conquest pregnant with vast moral and political possibilities. It is an object worthy of consideration.

Fifty years ago the Pacific Railroad, the Panama Railroad, the Mt. Cenis Tunnel, the International Telegraph and the Suez Canal, were visionary schemes. It seemed the acmé of poetical fiction when the poet spoke of girdling the earth in forty minutes, as the work of supernatural agency. Sir Humphrey Davy, making science the basis of fiction, attempted to arrive at some conception of the composition of distant planets and the nature of their inhabitants. We can now send a message across the Atlantic in a minute, and know with certainty something of the composition of planets, stars, and nebulæ. These achievements have become the common property of the civilized world.

The piercement of the Isthmus does not involve greater practical nor intellectual difficulties. Neither science, ability, nor energy, is wanting. Conviction of its utility, sufficiently wide spread to secure the popular good will, and leading to a national movement in favor of combined international action, will secure the early completion of this great marine highway.

To secure popular favor it seems only necessary to exhibit the material advantages which must flow from its execution. Some of the facts, showing how far the completion of the canal would affect the commerce of the world, have been stated.

A small space may be given to the probable revenue. The mod-

erate estimate given in Admiral Davis's report may be assumed as a basis, which may be safety taken as doubling itself in ten years.

The tonnage which would pass the Isthmus yearly is, at one dollar per ton toll, $3,094,070.

At end of the first year	$ 3,403,477
" " second "	3,712,884
" " third "	4,022,291
" " fourth "	4,331,698
" " fifth "	4,641,105
" " sixth "	4,950,512
" " seventh "	5,259,919
" " eighth "	5,569,326
" " ninth "	5,878,733
" " tenth "	6,188,140
Gross receipts for tolls during ten years	$47,958,085

This estimate is undoubtedly less than the revenue which will be received.

No conjectural estimate is made of the probable development of the agricultural and mineral wealth of the valleys of the Mississippi and the Amazon, of the shores of the Gulf of Mexico, Caribbean Sea, and Pacific coast of America. And yet, in attempting to form an idea of the probable revenue and actual value of this canal, all the industrial resources called into being by its influence should be taken into consideration. It is like opening the gate to commerce, which, for centuries, man has struggled to unlock.

No event in history has been followed by more marvelous consequences than the discovery of Columbus. So closely is man bound up with matter, that every conquest of nature not only adds to his material comfort, but opens new fields for the moral and intellectual progress of the race. America not only opened new industrial resources, but afforded the population of Europe an opportunity to escape from the social, moral, and physical oppression of caste, bigotry, and capital, which had become intolerable.

If we could lift the veil which conceals the future, and could see "the vision of the world and the wonder that will be," it is not improbable that we should see the vast elements of progress latent in the American continents, working out their legitimate and logical results, as wonderful as those which have transpired since the colonization of America.

We should see the industrial resources—which have drawn thither in the struggle for existence the most energetic of the races of the globe—giving occupation to a happy and united people. The hum of industry, and the din of the steam hammers, would mingle together

with smoke of furnaces and of factories, above the inexhaustible coal fields of Pennsylvania, Virginia, Illinois, and Iowa. The grain of Kentucky, Ohio, Indiana, and Kansas would be shipped to New Orleans, to be exchanged for the cotton and sugar of the South, and the coffee, dyes, and tobacco of Costa Rico, Havana, and Ambelema; the magnificent table lands of Mexico, Guatemala, Yucatan, and the plateau of Bogota, occupied by a people more highly cultivated and capable of appreciating the grandeur of the scenery and salubrity of the climate, and of utilizing the fertility of the soil and the physical advantages of those most favored regions.

Opulent cities would spring up in the bays of Tampa, Mobile, and Pensacola. New Orleans, Galveston, and Vera Cruz would rival Marseilles and ancient Venice. From the ports of Carthagena, Sabanilla, Maracaibo, and Para, would be shipped the produce of the valleys of the Magdelina and the Amazon. Great as would be the transformations effected by these changes, they would be less than those which have transformed the continent of America into a congeries of civilized States.

Such speculations have a sober basis of fact. They are not wholly useless if they attract the attention of those who have more time for patient investigation. Sufficient has been said to show that the objects to be attained merit consideration.

CHAPTER V.

Admiral Davis's Report—Table of the Tunnels of the different Isthmean Routes—Altitude of Ridge at Darien—Comparative Cost of Canals with and without Tunnels—Lift Locks and Thorough Cut—Tide in the Atlantic and Pacific—Moderate Lockage can not Obstruct the Navigation—Gisborne on Thorough Cut—His Error as to Velocity of Water—Objections to Strait—Tabular Statement of the Cost of Tunnels, English, French, German, and American—Tunnel of Mont Cenis—Hoosac Tunnel—Profiles of Mont Cenis and Hoosac Tunnels—Dimensions of Ship Tunnel—Cost of Open Canal—General Michler's Report—Guard Locks Necessary—Cost of System of Lift Locks—Conclusions Supported by Garella and Michel Chevalier.

IN compliance with a resolution of the Senate, dated March 19, 1866, we have an admirable report from Admiral Davis. In this report the relative merit of different lines is exhibited; carefully prepared tables, showing the amount of freight which would pass the Isthmus; a list of ninety publications and fourteen maps, are appended. Ten of these maps, based on recent surveys, supply much valuable information.

"It is to the Isthmus of Darien," says Admiral Davis, "that we must look for a solution of the question of an interoceanic ship canal." And he quotes from Airian, "who has made a careful study of this subject," the assertion that, "with regard to the Cordillera, in proportion as it advances, proceeding from the base of the Isthmus, it descends a good deal, and is only, so to speak, a range of hills or isolated peaks, the bases of which are intersected by ravines, which point out to engineers the true route of the canal. The Indians in the neighborhood of Caledonia Bay make use of these passages. One of them is elevated fifty metres (164 feet), and is covered with a luxuriant growth of mahogany, palm, ebony, and other trees." "This description," Admiral Davis remarks, "is not based on actual measurement, but from probabilities deduced from M. Garella's survey of another part of the Isthmus, and from data, equally conjectural, drawn from the published statements of Messrs. Cullen and Gisborne."

A thorough exploration may justify this conjecture, but no data exists for fixing the absolute altitude at 164 feet. The value of the statements of Messrs. Cullen and Gisborne may be contested.

It will be seen from the altitude given in the table below, that however correct in point of fact these opinions may be, they are not sustained by the figures taken from the maps accompanying the Admiral's report:

Table showing the length of Railroads and Canals, length of Tunnels, altitudes of Summits, estimated cost of some of the lines proposed for uniting the two Oceans, from actual surveys:

ROUTES.	LENGTH.	LENGTH TO BE CONSTRUCTED.	LENGTH OF TUNNELS.	ALTITUDES OF SUMMIT.	ESTIMATED COST.	CANAL OR RAILROAD.	AUTHORITIES AND REMARKS.
	MIL'S	MILES	MIL'S	FEET			
Tehauntepec	190	.....	.....	855	$16,900,000	Canal.	M. Moro.
"	.....	.....	.....	843	7,847,896	Railroad.	J. J. Williams
Honduras	234	234	.....	2956	.....	Canal.	Trautwine.
Nicaragua to Realijo	298	160	.....	174	20,000,000	"	Napoleon III.
" " Brito	194	.....	.....	600	32,000,000	"	O. W. Childs.
Panama	53⅔	.....	3 7/10	459	27,000,000	"	M. N. Garella.
"	48	48	.....	280	50,000,000	"	Col. G. W. Hughes.
San Blas	30	.....	7	1500	.....	"	McDougal.
Darien to San Miguel	42	.....	7 to 8	980	65,000,000	"	Gisborne.
" "	.....	.....	.....	1020	.....	"	Prevost & Strain.
" Lara to Sucubti	.....	.....	.....	610?	.....	"	Bourdial.
Atrato to Humboldt Bay	126	.....	3½	.....	145,000,000	"	Kennish.
" " "	149⅔	52⅔	2½	970	134,450,154	"	Lt. Michler, U.S.A.
" to Cupica	.....	.....	.....	.....	325,000,000	"	Trautwine.

From the above table it would appear that the altitude of the dividing ridge falls off toward the two extremities of the Isthmus, viz.: near the Tehauntepec and the Atrato routes, but the greatest depressions have been found between Aspinwall and Panama, and on the line by the way of Lake Nicaragua and Lake Monagua.

At the Isthmus of Darien *altitudes of from one to two thousand feet* are found. Cullen's pass of 150 feet proved to be estimated at one-ninth of its true height. The least elevation of the divide is that given by M. Bourdial. This engineer did not cross the Isthmus, and his statement is so vague, the reader is left in doubt whether he actually reached the summit. Notwithstanding this uncertainty, there still exists a faint hope that "it is to the Isthmus of Darien we must first look for a solution of the question of an interoceanic canal."

From another statement in this very valuable report, we feel reluctantly compelled to dissent. By imposing unnecessary conditions in the statement of the problem, its solution may be indefinitely postponed.

"The interoceanic canal," it is affirmed, "in width, depth, in supply of water, in good anchorage and secure harbors at both ends, and in absolute freedom from obstruction by lifting-locks, or otherwise, must possess, as nearly as possible, the character of a strait."

To insist that the canal must possess the character of a strait, may give rise to the necessity for a thorough-cut of such extreme depth, or a tunnel of so great length, as to render the work practically impossible. A line suitable for a thorough-cut may possibly be found, but so important a project should not be endangered by limiting its practicability to a communication of that nature.

If, by the employment of "lift-locks," the cost of the canal can be materially reduced, the question to be considered is, to what extent such structures would obstruct navigation? This question depends upon the amount of trade drawn to the Isthmus by the canal.

The relative cost of the two methods for piercing the Isthmus can be best determined by a comparison of the cost of a canal in an open country with one by means of tunnels. These considerations, since they afford criteria for judging of the merits of different routes, may be considered more minutely. Let us assume the trade passing over the Isthmus—were the canal now completed—to increase one hundred per cent. in ten years; there would then be 2,066 tons in transitu daily, requiring seven ships of about 300 tons burthen each.*

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* Present average of the tonnage of ships of the commercial marine is 380 to 400 tons. The calculation supposes a commercial year of 300 days, and that the same number of ships arrive daily.

The progessive increase in the size of ships will raise this average to between 500 to 1,000 tons; reducing the number of ships arriving at the Isthmus daily, to five and three respectively. But, assuming the smaller average, giving the larger number of seven ships daily passing through the canal; an increase of four hundred per cent. in the trade would be equivalent to fourteen ships, or to seven ships leaving opposite extremities of the canal, and passing each other daily upon homeward and outward voyages.

Locks of four hundred feet long by ninety feet wide can be filled or emptied in twenty minutes; and this time can be reduced for smaller vessels by additional lock-gates, and for larger vessels by an increase in the size and number of filling valves.

The entire trade likely to seek this route, increased four hundred per cent. of its present amount, could be passed through one lock in about four hours and forty minutes. As the vessels come from opposite directions, one-half of the number would be waiting for lockage at the same point, which would reduce the time required for this purpose to two hours and twenty minutes. Eight locks, having an average lift of twelve and one-half feet, would delay the increased commerce eighteen hours and forty minutes, and would raise the level of the canal fifty feet; while to raise the level one hundred feet the delay would not exceed two days.*

As a summit level may be a necessary part of any Isthmean canal, it is manifest that the resulting lockage can not seriously obstruct navigation. The design of an artificial strait may therefore be reasonably abandoned, if, by so doing, the extraordinary cost of tunneling is excluded by the employment of a small number of lift-locks.

On account of the rise of the tide on the Pacific coast guard locks, not much less costly than lift-locks, must be an essential part of any canal from ocean to ocean.

The mean tide of the two oceans is about the same.

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* The Egyptian correspondent of the Boston Advertiser, March 15, 1870, observes: "The channel at Lake Timseh has not much more than 19 feet of water, as on the day of opening. We met two steamers on their way to Bombay, an English vessel going for cotton, and the French steamer Asie. This was evidently all the business of the day, and from the report of the company, it is a fair average of the amount of work done. The company say they register one thousand five hundred tons a day."

The following statement exhibits more fully the tonnage and toll-receipts of the Suez Canal:

In December, 1869.....	9	steamers and sailing ships.....	40,000	francs.
In January, 1870.....16	"	"	170,000	"
In February, 1870.....28	"	"	269,000	"
In March, 1870.....52	"	"	450,000	"

Table of tides, according to observation, from Col. Totten's Report.

	PACIFIC AT PANAMA.	PACIFIC AT PANAMA.	ATLANTIC AT ASPINWALL.
	MAY & JUNE	NOV. & DEC.	AUG. & SEPT.
	FEET.	FEET.	FEET.
Greatest rise of tide	17.72	21.30	1.60
Least rise of tide	7.94	9.70	0.62
Average	12.08	14.10	1.16
Mean tide of Pacific above mean tide of Atlantic	0.759	0.14	.....

Mr. Lloyd found a difference of 27.44 feet between high and low water at Panama. The Red Sea is 3 inches higher than the Mediterranean. The Atlantic at Brest is $3\frac{1}{2}$ feet higher than the Mediterranean at Marseilles.

The small variation in the mean tide at Panama of the two oceans is probably due to the action of winds and the Gulf Stream. At Panama the highest flood tide rises about ten and one-half feet above the level of the mean tide of the Atlantic, and the extreme ebb falls about the same number of feet below it. The alternate currents through the new strait, caused by the rise and fall of the tide, would prove a serious inconvenience to navigation.

The Pacific tide, piling up at the head of the new cut, and entering the strait with considerable violence, would be propelled toward the Gulf in a manner analogous to the progression of the tidal wave in a river. Upon the ebb of the tide a reverse current would prevail. Navigation would not only be obstructed by these alternate currents, but the channel would be choked by drifting timber washed into the canal during the rainy season. Silt and sand would be deposited in bars at the outlet of the canal, or swept inward to form shoals where the current could no longer transport it.

Mr. Gisborne, in his report, devotes some space to speculations on these results. "There can be no doubt," he remarks, "that at high water there will be a current from the Pacific to the Atlantic, and that during the ebb tide there will be a current in the opposite direction. The extent of these currents, and the place of their greatest effect, depends on the comparative sectional area of different portions; and if the cross-section is uniform throughout, will be some time after high tide in the Pacific and at the Atlantic end of the canal. The phase of the tide wave (or the appreciable effect of the tide) will take one and one-half hours to reach from one end to the other, and presuming the current to be uniform in the whole length"——"the question may be examined as a maximum, *i. e.*, what will be the

surface velocity of a canal thirty miles long, having a fall of eleven feet, or with a horizontal bottom having at one end twenty-eight feet, and at the other thirty-nine?"

Employing Du Buat's formula, with the following quantities:

Mean depth	35.50	feet.
Mean width	183.50	"
Mean border	244.80	"
Area water section	6,147.255	"
Hydraulic mean depth	25.11	"
Fall per mile	0.33	"

he deduces a maximum surface velocity of three miles per hour. The assumed average fall per mile is strictly a variable function, and at its maximum would give a result greatly in excess of that deduced by Mr. Gisborne.

There is no reason for this assumption of a fall of 0.33 of a foot per mile. It directly involves the question to be determined, since the velocity depends upon the inclination of the surface. The value deduced by the formula is not the maximum but the minimum velocity attained in the canal upon the assumed fall per mile.

There is another error in Mr. Gisborne's statement. "The tide," he remarks, "would take one and one-half hours to reach from one end to the other, presuming the current to be uniform; what," he asks, "will be the surface velocity in a canal thirty miles long?"

This statement contradicts his calculations, and involves also the question at issue. If the tide travels to the end of a canal thirty miles long in "one and one-half hours," it is evident that it must move at the rate of twenty miles per hour, a velocity which renders Mr. Gisborne's strait impracticable for navigation.

In fact, neither assumption is tenable. The problem is very complex, or, rather, with the data given, indeterminate. It is well known that the tide is propagated up the channel of a river in a succession of long waves, or swells, and that when the tidal wave is entering the mouth of the river, the waves which have reached the head are returning. The same movement is observed, on an exaggerated scale, in the successive breakers which roll in to meet the one which is returning, after it has expended its force upon the beach.

In the case of the Isthmean Canal, the rising tide, after having passed the mean, will have a downward slope into the canal. In rivers, notwithstanding the local rise of the water, the slope is never reversed, but is simply reduced in its angle of inclination.

The problem involves the inclination of the surface, or the deter-

mination of the limits of tidal action at successive stages of the tide. While the head of water increases, there is also a constant increase of the retardation of the flow of water into the canal. The outflowing water will run more rapidly than the inflowing, on account of the indefinite area over which it will spread and the diminution of the retarding influences. Both outflowing and inflowing current will seriously obstruct navigation. The banks of the canal will wash away, and bars will accumulate about the mouth.

While these objections are valid against a thorough-cut canal without locks, they do not apply to a strait of a quarter of a mile in width. As the cost of a canal is the chief difficulty in the way of its construction, it is necessary to abandon the idea of a strait, and to adopt that of a thorough-cut with guard-locks, as the only known means of protecting the canal from the injurious effects of the tide.

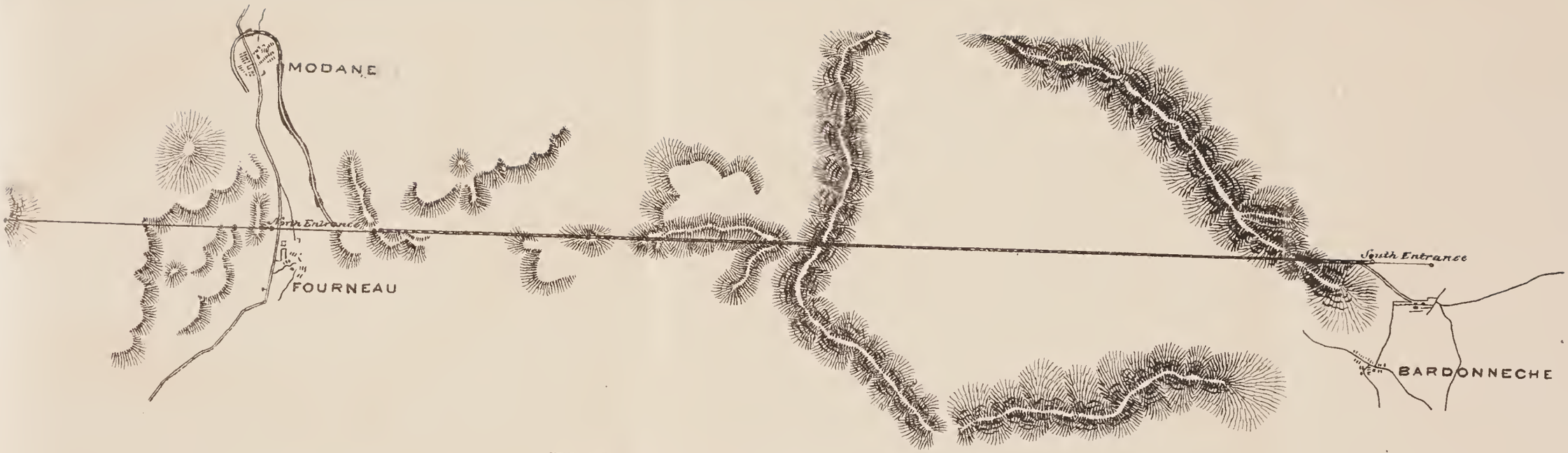
In order to form a correct opinion of the cost of canals with and without tunnels, attention is called to the expense incurred in the execution of this kind of work.

Dimensions and Cost of some English Tunnels.

		HEIGHT.	WIDTH.	THICKNESS OF ARCHING.	LENGTH IN YARDS.	KIND OF MASONRY.	TOTAL COST.	COST PER YARD.	YEAR WHEN BUILT.	MATERIAL CUT THROUGH.
		FT IN	FT IN	FT. IN.			DOLLARS.	DOLLS.		[earth.
1	Thames & Med. Canal.	39.0	35.6	.....	3960	BR'K	.....	145.00	1800	Chalk, Fuller's
2	Islington, Regents Can.	21.6	20.6	1.6	900	"	.....	.....	1812	London clay.
3	Tetney, Haven Canal..	16.2	17.0	1.2	2962½	"	563.405	192.50	1827	Various.
4	Walford, N. W. R. R.	26.6	27.0	1.6	1830	"	.....	.....	1838	Chalk.
5	Box Tunnel, G.W. "...	36.0	36.0	2.3	3121	"	1,561,500	500.00	1838	Freestone.
6	Littleboro', M. & L. "...	27.6	27.0	1.10½	2860	"	4,255,000	440.00	1841	Various.
7	Thames, Foot Passage..	22.3	37.6	2.6	400	"	2,273,570	5,685.00	1842	London clay.
8	Bletchingly, S. E. R. R.	30.0	30 0	1.10½	1324	"	486,185	351.00	1842	Shale. [sand
9	Saltwood, " "	30.6	30 0	2.3	954	"	562,710	590.00	1843	Lower green-

Canal tunnels are rarely larger than 16½ feet by 18 feet high. Supposing the same dimensions to obtain in French tunnels, the cost per lineal yard of the following named tunnels will furnish a basis for comparison :

NAMES OF TUNNELS.	LENGTH IN YARDS.	COST PER YARD.
Norieu, St. Quinten Canal	13,128	$ 14.00
Pouilly, Canal de Bourgoyne	3,660	393.75
Soussay, Canal de Bourgoyne	3,852	45.50
Maurages, Canal de Marne	5,320	325.00
St. Argnan, Canal d'Ardennes	288	200.00



PLAN AND PROFILE OF MONT CENIS TUNNEL

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Among railroad tunnels, the following are selected from different parts of the continent:

NAMES OF TUNNELS	LENGTH.	WIDTH.	HEIGHT ABOVE RAILS.	NUMBER OF SHAFTS.	SECTION ABOVE RAILS.	COST PER RUNNING YARD.	TIME IN CONSTRUCTION.	MATERIAL.
	YDS.	FT.	FT.		SQ. FT.	DOLS.	MO'S.	
Chezy	496	24.27	18.04	0	365.84	411	32	Sand and clay.
Arschwiller	2928	24.27	18.04	6	374 77	176	95	Sandstone.
Alouette	1350	25.58	20.00	21	428.68	305	23	Clay.
La Motte	2799	24.92	21.98	.....	519.71	180	30	Clay, marl, sandstone.
Nerthe	5072	26.24	24.60	24	.....	412	36	Limestone.
St. Martin	1509	25.25	19.35	10	415.34	475	60	Porphyritic rock.
Blaisy	4483	26.24	24.60	20	.....	.....	.....	Limestone.

The cost of the Thames tunnel was greatly increased by a shield, designed by Brunel, to keep out the water. Omitting this tunnel from comparison the English works exceed the French, or Continental, in cost of construction.

The boldest work of the kind yet undertaken is the Mt. Cenis tunnel, to connect France and Italy by a continuous railway. In length it is seven miles, with a width of 26′ 6″ and a height of 20′ 8″. Its completion is anticipated in April, 1871.

The monthly advance by hand-labor was twenty-two and a-half yards. The progress is doubled by machinery, and during the past year has averaged 330 feet per month. Air, compressed by water power, is conveyed inside to give motion to chisels, which form cavities for blasting by gunpowder. The average progress per day in 1865, with the machinery, was about 9 feet.

The estimated cost was $550 per running foot, but the rate was increased to $640; the entire cost of the tunnel being estimated at $9,200,000. The use of machinery at Mt. Cenis was found to expedite the work, but at an increase of expense.

The trial of machinery at the Hoosac tunnel, upon the Troy and Greenfield Railroad, has not been favorable to its employment. This tunnel will be four and three-quarter miles long. Originally projected with a width of 24 feet, and a height of 20 feet, it has been contracted to 14 feet wide, and 18 feet high. The estimated cost was $2,696,229. The rate first assumed was $137 per running foot. The rate per cubic yard varies from $5 to $22, and $30, for the excavation of shafts.

The contract prices for the Hoosac tunnel, in 1869, were as follows:

Tunnel enlargement, per yard	$ 16.00
Heading enlargement, east end, per yard	9.00
Heading enlargement, west end, per yard	9.75
Full size tunnel extension, east end, per yard	11.00
" " west end, per yard	12.00
" " central section, per yard	14.00
Central drain, with air and water pipes complete, per lineal foot	13.00
Sinking shaft (27x15), per foot, depth	395.00
Pipes (10 inch), set in shaft	6.00
Arching (in brick at $9 per M), per M	22 00
Excavating and constructing 50 lineal feet of stone arch, and filling	23,000.00

Although more than two hundred railroad tunnels have been constructed in the United States, and an unknown number of canal tunnels, facts in regard to them are difficult of access. Recent bids for tunnel work upon United States railroads have been offered at $5.40 per cubic yard for excavations. Canal tunnels, of the ordinary dimensions of 297 square feet area, would cost $113.20 per running foot.

The uncertainty of the nature of tunnel excavation, the unexpected difficulties to be overcome, baffle all anticipatory estimate. The variable rates in the preceding tables establish this fact. The average cost per running yard upon French canals is about $152, which sum probably includes arching. Rates of labor in the United States would increase the cost about four times this amount.

Comparing the contract price of American tunnels, as given above, with the table of English tunnels, and bearing in mind that the cost of arching is included in the latter, we find in Nos. 3, 6, and 9, the cost of English tunnels is in excess; number 3 being nearly double, and number 9 one-tenth more, while, in every other case, the cost at American rates is greater, varying from one-third to five and one-half times more.

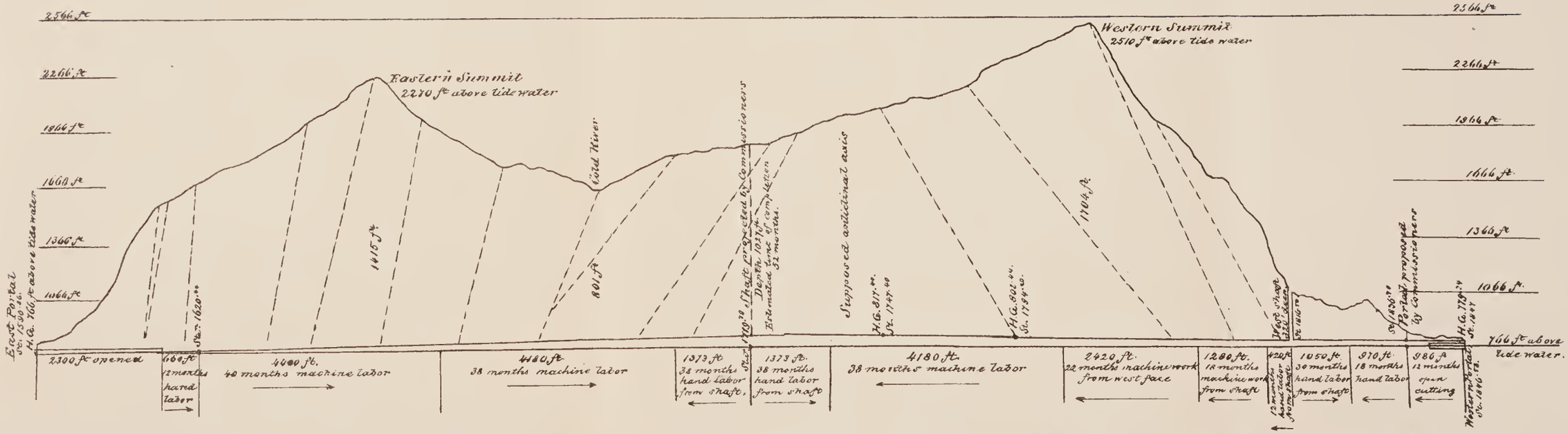
The schale, schist, and trachyte of the Isthmean ridge is of variable consistence. Many places exhibit friable, seamy strata, disintegrating upon exposure to the atmosphere. A tunnel of the dimensions to admit the passage of ships, when carried through rock of this character, will require a lining of masonry to prevent falling material from obstructing the way.

To pass ships with the topmast struck, the intrados of the arch should be 100 feet above the surface of the water. A semi-ellipse with semi-transverse, and conjugate diameters of 100 feet, added to the canal prism of thirty feet in depth, will give an area of tunnel equal to 10,104 superficial feet, or to 1,976,263 cubic yards per mile.

Assuming that the cost of tunneling through the Isthmus can be

PROFILE OF THE HOOSAC TUNNEL

Vertical Scale 750 ft to one inch
Horizontal Scale 2500 ft to one inch



Tunnel Enlargement per yard	$ 16.00
Heading enlargement East end per yard	$ 9.00
" " West " " "	$ 9.76
Full size tunnel extension East end per yard	$ 11.00
" " " " West " "	$ 12.00
" " " " Central Section " "	$ 14.00

Central drain with air and water pipes per lineal foot	$ 13.00
Sinking shaft (25 x 15) per foot in depth	$ 395.00
Pipes (10 inch) set in shaft per foot in depth	$ 6.00
Arching (in brick at $9.00 per M) per M	$ 22.00
Excavating and constructing 50 lineal feet of stone arch and filling	$ 23060.00

Extreme length of Tunnel 4¾ miles
Size in rock 24 x 20 feet high, when arching is required 26 x 21½ feet high.

executed at $10 per cubic yard, we shall have 19,762,630 dollars as the cost of one mile of tunnel. Estimating the excavation alone at present contract price, $5.40 per cubic yard for small tunnels, one mile of ship tunnel will cost $10,670,820. An open canal upon the line of the canal proposed by General Michler, uniting the Atrato with Humboldt Bay, will cost, according to the estimate of that officer, $1,792,202 per mile.

This amount, taken from the careful and elaborate estimates contained in General Michler's report, may be assumed as a basis of comparison of the two proposed methods of intermarine communication, viz.: by uniting the two oceans upon one level by a tunnel, or by means of a moderate number of "lift-locks." Eight locks, four at each end of the canal, or sixteen locks, eight at each end of the canal, will raise the summit fifty feet above tide in the first case, and one hundred in the second, and will cost eight millions, and sixteen millions respectively. Since two guard locks will be requisite for either method of communication (*i. e.* by "strait," or canal with lift-locks), their cost should be excluded from the above sums, which are thereby reduced to six millions, and fourteen millions of dollars. These sums are fixed as the probable limits of the cost of a system of lift-locks sufficient to overcome the divide of the Isthmus, and also to supply the reader with a standard, by which he may judge of the merits of different routes.

The construction of a ship tunnel is, as has been said, "a herculean task," and it is not apparent that "the prejudice against it will be removed by the operations at Mt. Cenis." A moderate number of lift-locks seems preferable to a tunnel of one mile in length, which, in turn, would be more economical than an excessive number of locks. A greater number than we have mentioned may be deemed excessive.

A thorough-cut upon the level of the ocean would be a desirable method of canalization, but it seems like hampering the important design of an intermarine highway for the commerce of the world, with an impracticable condition, to insist that it should possess "absolute freedom from obstruction by lifting locks," or that it should possess, in any degree, the "character of a strait."

In this statement I find I have the support of M. Garella and Michel Chavalier. The opposition to the system of lift-locks appears to have originated in the objection expressed in Mr. Wheaton's letter to Mr. Buchanan, to the large number of these structures, recommended in M. Moro's plan for the canalization of the Isthmus of Tehauntepec.

CHAPTER VI.

Our Geographical Knowledge of the Isthmus—The Value of Early Narratives and Histories—Projects for Uniting the two Oceans by Canals and Railroads—Criteria for Assisting the Judgment—Tunnels, Harbors, Locks, Dimensions of Canal—Tehuantepec—The Garay Grant—Moro's Survey—Barnard's Survey—Honduras—A Better Route Practicable—Nicaragua—Louis Napoleon's Scheme—Col. Child's Report—Variations of Route—Advantages of this Line—Chiriqui—St. Clair Morton—No Information Extant—Costa Rica—Railroad Practicable—Great Altitude of Ridge—Panama—Information Abundant—Garella's Route—Hughes's Route—Advantages—Cost of Canal on this Route—Mexican Desagues—Panama and Aspinwall—Harbors Easily Improved—Panama Railroad Company—San Blas and Bayano River—F. W. Kelly—McDougal's Survey—Fine Harbors—Tunnel Seven Miles Long—Darien—Between Caledonia Bay and the Gulf of San Miguel—Baron Humboldt—Vasco Nunez—Paterson's Colony—Causes of Its Failure—Dr. Cullen and Savana River—Reports the Ridge 150 Feet—English Company—Concessions of the Granadian Government—Mr. Gisborne Sent to Darien—His Speculations—Delayed at Carthagena—Stopped by the Indians—Supposed Success—Misunderstanding with Dr. Cullen—Returns to England—Provisional Directory Organized—Controversy Between Sir Charles Fox and the London Times—Combined Expedition of Four Governments—Lieut. Strain's Misfortunes—Fails to Find a Pass—Dr. Cullen and Mr. Gisborne's Failure—Captain Prevost Fails to Cross—Dr. Cullen Changes His Opinion—French Expedition under Bourdiol—Fails to Cross—Granadian Expedition Fails—Condensed Statement of the Results of all the Expeditions—Captains Prevost and Parsons see Evidences of a Pass—Darien Not Yet Explored—San Miguel to the Gulf of Urabá—The Atrato Route—Successful Survey—Representations of Unprofessional Persons—Gorgoza and De La Charme—Their Route—Trautwine—Mr. Porter and Kennish's Routes—Lieut. Michler's Route—Extracts from Michler's Report—Tunnel Two and One-Half Miles—Cost too Small—Barometric—Levels—Humboldt's Opinion.

HAVING hastily sketched the relation of the proposed canal to the commerce of the world, its importance is sufficiently apparent to justify a careful consideration of the condition of our knowledge of the geography of the Isthmus. The facts and reasoning of previous chapters will furnish a standard, in the absence of a better, for trying the merits of the routes about to be described, and will indicate the nature of the deficiency to be supplied by future explorations.

The American Isthmus extends in length about twelve hundred miles, from the Coazacoalcos River, in Mexico, to the valley of the Atrato, in Columbia. It includes the Mexican States of Tehuantepec, the Republics of Yucatan, Guatemala, Balize, Honduras, San Salvador,

Nicaragua, Costa Rica, the Mosquito Kingdom, and the State of Panama, one of the States of Columbia. Embracing a varied and salubrious climate; a rich soil, clothed with the luxuriance of tropical vegetation; ruins of an ancient people, consisting of vast and silent cities, whose impressive but grotesque architecture, embodying a civilization unique and insular, is overgrown with forest of flor de robles, mahogany, and palm; divided throughout its entire length by a volcanic dyke, rising to altitudes of five to six thousand feet, and sinking into depressions two hundred and eighty feet above the level of the sea; concealing in its strata the matrices of gold and precious stones; expanding in Yucatan to a width of six hundred and fifty miles, and contracting at San Blas and Darien to thirty or forty miles—this connecting link, the result of a submarine endogenous movement subsequent to the elevation of the continents which it unites, opposes a solitary but not insurmountable barrier to the commercial union of the two oceans.

The narratives of Dampier, Wafer, the adventures of the Spanish Buccaneers who infested the South Sea, and the descriptions of Las Casas, Fonseca, Don Andres de Ariza, however interesting historically, add but little to the physico-geographical knowledge of the country. These histories contain accounts of earthquakes as terrific as that which has recently visited the coast; of sieges notable for bold assault and gallant defense; of gold mines opened and abandoned; of strange fauna, birds of splendid plumage, and a tropical flora of gorgeous colors; but the reader will seek in vain for information of practical value in determining the question of a practicable route for an interoceanic ship canal.

Recent explorers have supplied much accurate information of special routes. The following table exhibits the different projects for uniting the Atlantic and Pacific:

1. Tehuantepec, by the Coazacoalcos and Chicapa.
2. Honduras.
3. Nicaragua, from San Juan de Nicaragua and Lake Niaragua, five variations, viz.:

R. San Carlos, G. de Nicoya,
R. Nino, Tempisque, G. de Nicoya,
R. Sapoa, B. Salinas,
San Juan del Sud,
and Brito.

From San Juan de Nicaragua, by way of Lake Nicaragua and Managua, three variations, viz.:

R. Tamarinda. B. Realejo. B. Fonseca.

4. PANAMA, four distinct routes, viz.:

Gorgona, Panama.
Trinidad, Caymito.
Navy Bay, R. Chagres, R. Bonito, R. Bernardo.
San Blas, R. Chepo.

5. DARIEN, including the old province of Chocó; the different routes and the variations are five in number, viz.:

B. Caledonia, G. San Miguel.
Rs. Arguia, Paya, Tuyra, G. San Miguel.
B. Napipi, Cupica.
R. Truando, Kelley's Island.
R. Tuyra, G. Urabá or R. Atrato.

The above lists include canal projects; the following list enumerates the projected railroads:

I. Coazacoalcos, Tehuantepec.
II. B. Honduras to G. of Fonseca.
III. R. San Juan, Nicaragua, Managua.
IV. Port Limon to Caldera, Costa Rica.
V. Chiriqui inlet to Golfo Dulce.
VI. Aspinwall, Panama, (railroad finished.)
VII. Gorgon B., Realijo. } Nicaragua.
VIII. Gorgon B., San Juan del Sur. }

Before describing the routes above enumerated, some criteria for assisting the judgment may be brought together, as follows:

1. The Isthmean Canal may be a thorough-cut, with guard-locks.

2. It should be without a tunnel.

3. It may have a summit-level and moderate lockage, to avoid excessive tunneling and cutting.

4. Great advantages in other respects—viz.: shortness of line and fine harbors—may compensate for a short tunnel.

5. The route should possess good harbors, or such as can be easily improved.

6. Dimension of the canal and size of the locks. The canal should be sufficiently wide to permit ships to pass easily, or it should have convenient turn-outs.

The width of the intermarine canal proposed by Mr. Kennish, to unite the Atrato and the Pacific, is estimated to have 200 feet. General Michler assumes a width of 100 feet, and states that vessels can pass alternately from one end to the other, employing tug-boats and telegraphic signals to avoid confusion.

The canal now in process of construction, under the direction of General Wilson, around the Des Moines rapids on the Mississippi, has a width of 250 feet in embankment.

The Engineer in charge of the canal around the falls of the Ohio at Louisville, proposes a width of 120 feet, which is the same as that of the Caledonia Canal.

The Suez Canal has a minimum width at water surface of 190 feet. This last dimension, with a sufficient number of turn-outs, would be suitable for the canal across the American Isthmus.

The locks of the Des Moines Canal are 380 feet between gates, by 80 feet wide. General Weitzel proposes, for the Louisville Canal, locks 400 feet between gates, and 100 feet wide. The Isthmean locks may be 400 feet between gates, and 90 feet wide.

Locks of these dimensions, if all unnecessary dressing of the stone is dispensed with, may probably be erected for one million of dollars.

It is unnecessary to mention other ship canals and locks, built for the accommodation of ships of less tonnage than those which would make the intermarine transit.

The following description, commencing at Tehuantepec, will treat of each route in succession:

TEHUANTEPEC.

In March, 1842, Santa Anna, "for the purpose of aggrandizing the nation and rendering the people happy," granted certain privileges to Don Jose de Garay, to enable him to open a line of communication between the Atlantic and Pacific oceans, through the Isthmus of Tehuantepec. The route was to be neutral to all nations at peace with the Mexican Republic. The "negotiation" was permitted to hold for public use all unoccupied land, not more than one-fourth of a league on either side of the line, which was conceded to them in *fee simple*. The right of collecting dues was conceded for fifty years, and the exclusive privilege of freight, by steam vessel or railroad, for sixty years.

The survey was intrusted to Sr. Moro, an Italian engineer of distinction. The distance from sea to sea was ascertained to be 135 miles in a straight line. Wide plains and table land adjacent each ocean were found to be broken by the Andes, rising to the height of 650 feet above the level of the sea.

Thirty miles of the Coazacoalcos River, after passing the bar, is navigable for ships of the largest class, and fifteen miles for vessels of light draught, leaving 115 miles of railroad to be made.

Sr. Moro, taking the dimensions and cost of the Caledonia Canal

as a standard, estimates the cost of a similar ship canal across the Isthmus * at $17,000,000. He includes in his estimate the cost of one hundred and sixty-one (161) locks, which may be reduced to one hundred and twenty. These results were not deemed satisfactory.

The privileges granted to Mr. Garay were secured by P. A. Hargous and Major (now Brevet Major-General) Barnard, Corps of Engineers. W. H. Sidell and others were employed to survey the route of a railroad. Of this survey we have the very interesting report of J. J. Williams, containing information of the statistics, geology, and topography of the country. The summit is 855 feet above tide; the entire length of the line is 190 miles. A summit-level and tunnel would be necessary to carry a canal across the ridge. Com'd Perry and Lieut. Temple, U. S. N., found about twelve feet water on the Coazacoalcos bar. The bar is supposed to be composed of hard clay, admitting of a permanent improvement. Capt. Basil Hall, R. N., and Com. Shubrick, U. S. N., speak of the Pacific terminus at Ventosa Bay as exceeding boisterous and unfavorable for anchorage.

The merits of this route have been minutely described by Col. J. J. Abert, Chief Corps Topographical Engineers, and Col. G. W. Hughes, of the same corps; and by common consent the route is regarded as possessing "little merit as a practicable line for the construction of a ship canal."

HONDURAS.

A barometric survey was made of this route. With excellent harbors, it is obstructed by an elevated dividing ridge. The topographical features of the country indicate the probable existence of a more favorable pass. A better route may be found by starting from the Gulf of Dulce, and proceeding toward the town of Guatemala; or by starting from the same point, a more southerly direction appears to possess advantages. Inference from maps of this region must be received with caution. The route is condemned by Admiral Davis.

NICARAGUA.

With the exception of the Panama route, no Isthmean project has received so careful an examination as the lines passing through

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* The Caledonia Canal is 25 miles long, and 122 feet wide at water surface. Dimensions of locks, 178½ by 39 feet. Lockage, 95 feet.

Lake Nicaragua. This part of the Isthmus widens into continental proportions of great fertility. The productive and industrial development of this country, by means of railroad or canal, would supply a material addition to the commerce of the world. With the growth of Central America, our gulf ports—Galveston, New Orleans, Mobile, Appalachicola, Pensacola, Tampa Bay, and Key West—would increase in military and commercial importance.

This line possesses additional interest for the political reasons adduced by the Emperor Napoleon III, in a memoir prepared by him when a prisoner at Ham. Arranged with method and prepared with care, this pamphlet bears the impress of a sagacious judgment. "In order," says the writer, "that the canal should become the principal element of the advancement of Central America, it must be cut, not through the narrowest part of the tongue of land, but through the country which is most populous, the most healthy, and the most fertile, and which is crossed by the greatest number of rivers, in order that its activity may be communicated to the remotest part of the interior. England will see with pleasure Central America become a flourishing and powerful State, which will establish a balance of power by creating in Spanish America a new center of active enterprise, powerful enough to give rise to a feeling of nationality, and to prevent, by backing up Mexico, any further encroachment from the North."

The line selected by Louis Napoleon (although he errs in his statement of distance), has not been improved by the changes in location proposed by subsequent engineers. All these routes commence at San Juan de Nicaragua, and follow the San Juan river to the Lake Nicaragua. From this lake three other routes pass through Lake Managua to Realijo, and to the Gulf of Fonseca. Lake Managua is about twenty feet above the level of Lake Nicaragua. The dry season suspends the flow of water between the lakes, and the question arises whether, even by the aid of a dam, sufficient water can be stored in the smaller lake to feed the summit level on each side of it during the dry season.

Col. Childs's route terminates at Brito; a fifth at San Juan del Sud, and three other variations of route near the same point of the Pacific coast. Col. Childs's report, which is very complete, was submitted to a Board of English Engineers, and to Colonels Abert and Turnbull, of the Corps of Topographical Engineers, U. S. A. Although the survey was thoroughly and scientifically executed, the route was condemned by these officers, because of the insufficiency of the harbors of Brito, and the small dimensions of the canal proposed by Colonel Childs.

The length of the canal was divided into sections, for the convenience of description and estimation of the cost:

	MILES.	FEET.
Western division, from Brito to the Lake	18	588
From Lake Nicaragua to head of San Juan	56	500
Slack water of seven dams on the San Juan	90	800
Canal to San Juan del Norte	28	505
Total distance	194	393

The maximum width of the canal was designed to be 118 feet, and the depth 17 feet. The descent from the lake to Brito was accomplished by fourteen locks.

The following table exhibits the distances from sea to sea of the proposed lines originating at San Juan del Norte:

ROUTES FROM THE PORT OF SAN JUAN TO THE PACIFIC.	LENGTH OF THE RIO SAN JUAN.	DISTANCE ON LAKE NICARAGUA.	FROM LAKE NICARAGUA TO THE PACIFIC.	FROM LAKE NICARAGUA TO LAKE MANAGUA.	DISTANCE IN LAKE MANAGUA.	DIST. BETWEEN LAKE MANAGUA AND THE PACIFIC.	LENGTH OF ACTUAL CANAL.	TOTAL LENGTH.
	MILES.	MILES.	MILES.	MILES.	MILES.	MILES.	MILES.	MILES.
To Brito	119	57	18	.....	.....	.....	137	194
Fonseca, Tamarinda	119	120	.....	4	50	16	139	309
Realijo	119	120	.....	4	50	45	168	338
Fonseca, Estero Real	119	120	.....	4	50	20	143	313

The ports on the Bay of Fonseca, and at Realijo, are good, but the other ports designated as terminal points upon the Pacific are not so favorable for shipping. San Juan del Norte, the initial point upon the Atlantic of all these routes, will not admit ships of large draught, and the harbor is rapidly deteriorating. All harbors of Central and South America receiving rivers, and opening to the northward, are decreasing in depth. The incessant wave-beat, caused by the trade-winds and northers, acts like a ponderous hammer, wielded by an irresistible force, whose unceasing efforts, for six months of the year, are exerted to force the sand into the entrance of the harbors, and to arrest the sediment brought down by the rivers. The result is a tortuous and variable channel, and a shifting and shoaling bar.

The deterioration of the harbor of San Juan de Nicaragua, or Greytown, has been minutely discussed by a board of scientific officers of the United States Corps of Engineers, and of the Coast Survey Department. Their conclusions were unfavorable to the improvement of the harbor.

Where the Cyane lay during the bombardment of Greytown a luxuriant grass marsh is now growing. It has not been many years since this harbor afforded refuge for shipping of ordinary draught, but it is not unusual, at the present time, to find the harbor so completely closed during a storm that a pedestrian may walk dry-footed across the former entrance. Upon such occasion the harbor of Greytown is converted into a lagoon until after the storm, when the accumulating water of the San Juan erodes for itself a new outlet to the ocean.

It is apparent some other initial point must be found before this route can be seriously considered as a suitable terminus for interoceanic communication. Monkey Point is said to supply a good anchorage, and has been suggested for this purpose. Monkey Point affords anchorage for ships drawing rather more than three fathoms. By joining the island with a breakwater of *pierre perdu*, of the length of about twelve hundred feet, a good harbor, affording five fathoms water, can be obtained.

The writer is not aware that any surveys have ever been made for connecting this point with the San Juan river, or with the lakes. It is therefore unnecessary to mention other reports upon the same route, or to do more than to refer to the plans, profiles, and details of the "Interoceanic Canal of Nicaragua," submitted at the Paris exhibition by L. J. Thome de Gamond. The report of M. de Gamond is not at hand.

A healthy and productive country; two lakes affording an inexhaustible supply for a summit level; a divide easily overcome at an altitude represented as 174 feet, and the convenient channel of the San Juan, through which the waters of Lakes Managua and Nicaragua find their way from an amphitheater of hills to the Atlantic ocean, are advantages which engineers and capitalists are loath to abandon, and which the reader relinquishes with regret. We may expect, therefore, to find the question continually revived. But its advantages have been overestimated.

The San Juan river has cut an outlet for the canal through the ridge, separating Lake Nicaragua from the Atlantic; but to pierce the divide on the opposite side, which separates the lake from the Pacific, a tunnel of about six miles in length will be requisite. The altitude of the divide is six hundred feet above the level of the lake. The singular omission in Colonel Childs's report may have led Admiral Davis to overlook so important an objection, or perhaps he may have thought it unnecessary to multiply objections to a route which appeared impracticable upon other grounds.

CHIRIQUI.

The so-called Isthmus of Chiriqui, lying between Panama and Nicaragua, was explored by the late Lieut. St. Clair Morton, who was killed in the siege of Petersburg. Lieut. Morton crossed the Isthmus twice, and pronounced the route practicable for a railroad. As no notes of this survey are extant, curiosity in regard to this route must remain unsatisfied. Lieut. Jeffers, U. S. N., speaks favorably of the harbors. Mr. Evans, the geologist, discovered an inferior kind of coal. Another reconnoissance may develop some important information.

COSTA RICA.

A railroad has been projected from Port Limon, near the tenth parallel of latitude on the Atlantic, to Caldera, in the Gulf of Nicoya. Rising to an altitude of 5,100 feet the route passes through a salubrious climate, and over a productive soil. A macademized road, 134 miles long, with five stone bridges, has been completed along this line. As a route for a ship canal the altitude of the summit appears to exclude it from further consideration.

PANAMA.

As the passenger route and highway of the trade between the Atlantic and Pacific States of America, the mention of this line arrests attention. Information in regard to it is full and accurate. Here, alone, in all Central America, a railroad unites the two oceans. Confining his remarks to the project of M. Garella, Admiral Davis pronounces his condemnation of the route.

M. Garella's route, starting from the Bay of Limon, on the Atlantic, following the valley of the Chagres, ascending with 17 locks to the summit, which it passes with a tunnel 17,500 feet in length, at an altitude of 135 feet above high water in the Pacific, and descending with 18 locks, terminates at the Bay of Vaca del Monte, on the Atlantic. The altitude of the ridge to be pierced is 459 feet. The commission of the "*Ponts et chaussés*" appointed to report upon Garella's project, object to the expense of tunneling, and to the absence of evidence of the sufficiency of the mountain streams to feed the summit level.

But a tunnel is not a necessary plan of piercing the Isthmus at this point, nor is a summit level 135 feet above high water an unavoidable necessity. The Panama railroad passes the divide without a tunnel, at an altitude of 280 feet above tide. The fact that a route possessing such advantages should be found so near the line of M.

Garella, encourages the belief that a more critical examination of other prescribed routes may be rewarded with the same good fortune.

The merits above mentioned justify a more attentive consideration. The advantages of the route may be enumerated as follows:

1. A divide 280 feet above tide.

2. Distance between oceans 48 miles.

3. The Chagres river, emptying into the Atlantic, and the Rio Grande, flowing into the Pacific, together with the smaller rivers, Maraboso, Obispo, Dominica, Mandingo, which can be made tributary to the summit level of the canal. The rainfall in this region varies from 90 to 100 inches, being three times the amount which ordinarily falls in the United States.

4. The harbors at the termini, Panama and Aspinwall, have accommodated the trade of California and the Atlantic States, and are far superior to those of Port Said and Suez.

5. Tunnel unnecessary.

Possessing such advantages, the objections which have led to the ignoring of this route should be noticed.

The objection of the Commission of French Engineers to M. Garella's project has been mentioned. "The river Chagres," it was observed, "was gauged at Cruces and Gorgona, but the river is to be tapped above these points."

The summit upon Garella's line is 459 feet above tide, while upon the line of the Panama railroad it is but 280 feet. Garella proposes to pierce the ridge, at 135 feet above tide, with a tunnel three and four-tenths miles in length. No tunnel is required upon the other line.

Estimating the tunnel of M. Garella at the present contract price in the United States, this part of the work alone will cost $57,623,380.

Add 47 miles of open canal.....	84,232,491.
Total cost of canal.....	$141,855,871.

A canal by the aid of locks can be constructed between the two seas, upon the line proposed by Col. Hughes, at a much less cost.

Assuming the same dimensions of canal—100 feet wide by 30 feet deep—and the same prices as above, taken from General Michler's report upon the survey of the canal for joining the Atrato and the Pacific, and we obtain the probable cost of constructing a canal upon this line, as follows:

For 50 miles of open canal.....	$ 89,610,150
12 locks raise the summit level 75 feet.....	12,000,000
Breakwater, ship basin, and contingencies.....	8,000,000
Total cost of canal.....	$109,610,150

This diminution of cost of $32,245,721, due to the absence of a tunnel, upon this route, allows of a margin more than can be required for increasing the number of the locks, or for building, graving docks, and other auxiliary conveniences in the harbors.

The execution of this work would require a cut of less dimensions than the famous Mexican Desague of Huehuetoca, referred to by Humboldt, and described by Admiral Fitzroy as "200 feet deep and 300 feet wide for nearly a thousand yards, and above 100 feet deep through an extent of nearly a thousand yards, (making altogether two miles of distance in which the vast excavation would be capable of concealing the mast-head of a first-rate man-of-war, executed in the last three centuries in Central America,) should induce us to listen respectfully to the plans of modern engineers, however startling they may appear at first."

Another objection remains to be considered: "Navy Bay is an insecure anchorage, and the harbor upon the Pacific is altogether insufficient for vessels of even moderate draught." "M. Garella is obliged to include in his estimate the sum of a million and a quarter dollars for the improvement of this harbor."

On account of the rise of the tide, which varies as much as 22 feet, vessels are compelled to anchor two and one-half miles from Panama, and the passengers and freight are transported in light-draught steamers. These difficulties may be converted, by the use of docks, as in English harbors, into an advantage. The withdrawal of 20 to 23 feet of water at extreme tides affords extraordinary facilities for constructing ship basins and docks upon the natural pavement of rock which covers the bottom of the bay in front of the City of Panama.

On the other side, Limon Bay possesses sufficient depth of water, but is open to "northers." The entrance of these dangerous winds may be prevented by a stone breakwater, or one composed of screw piles, driven sufficiently near to support iron or flanged plates, sliding vertically into position, one above another, until the requisite height is attained, and braced strongly at the back.

Notwithstanding northers, steamships arrive and depart regularly. The Royal Mail Steamship Company are building wharves of stone and iron, and the railroad company has projected a breakwater for the protection of shipping.

Colonel G. W. Hughes, in a letter to the Hon. J. M. Clayton, at that time Secretary of State, makes the following observations in regard to this route: "The line I have traced for a railroad is, I think, more favorable for a ship canal than that suggested by M.

Garella. If we adopt the same depth of cutting he suggests for an open cut, it will leave the bottom of the canal 44 feet above the level of the Pacific at high tide. This would be about ten feet lower than the bed of the river at Gorgona. An open cut two hundred feet deep would obviate all difficulty in crossing the Chagres at Gorgona, while the Rio Grande, the Obispo, and the Mandingo might be converted into an immense reservoir for supplying the summit-level with water, and the Rio Chagres above Cruces, and the Pedro, Miguel, Camero, etc., would furnish the lower level. A spacious tide basin might be constructed at the mouth of the Rio Grande, a few miles west of Panama."

For this project, so favorably recommended, it is necessary to obtain the consent of the Panama Railroad Company to the use of land belonging to their reservation.

SAN BLAS AND BAYANO RIVER.

This route is one of several surveyed under the generous patronage of F. W. Kelly and others. The map of Mr. McDougal, the surveyor and engineer, and the report of Admiral Davis, furnish some interesting facts. The narrowest part of the Isthmus is found here, being thirty miles from ocean to ocean, and here the tide of the Pacific is said to approach within fifteen miles of the Atlantic coast.

Mr. McDougal proposes to pierce the ridge, which has an altitude of 1500 feet, at a height of $93\frac{1}{2}$ feet above mean tide, by a tunnel seven miles long. The harbor of San Blas is deep and spacious. The channel leading into the Bay of Panama has not less than eighteen feet of water at mean low tide, while the rise of the water is sixteen feet. This result, Admiral Davis observes, does not agree with the admiralty charts.

The map indicates the probable existence of a better route to the north-west, and the surveyors were satisfied they saw evidences of a depression in that direction.

Admiral Davis quotes the well-merited compliment of Sir R. Murchison, to the zeal and energy with which Mr. Kelly has pursued "this great and philanthropic object," in which "all civilized nations are deeply interested."

DARIEN.

Between Caledonia Bay and the Gulf of San Miguel every effort to make a thorough exploration has resulted in failure. Disappointed expectations, arduous but fruitless labors, conflicting reports, failure, starvation, and death have stamped with ill omen every attempt to

cross this part of the Isthmus. Baron Humboldt has directed public attention to Darien, and Admiral Davis expresses his deliberate conviction that to this part of the Isthmus we must look for a solution of the question of interoceanic ship communication.

The history of so many attempts, proving so unexpectedly disastrous, supplies much curious and valuable information. From the Paterson colonization scheme to the unfortunate expedition of Lieut. Strain, one word will characterize every attempt. The first settlement of Vasco Nuñez, in 1510, after eight years of calamitous trial, was abandoned.

Paterson's colony was remarkable in the causes which led to its inception; in the ability and statesman-like views of him who conceived a design so vast and benevolent; in the governments enlisted in its favor; in the sufferings of the colonists, and in its final abandonment.

William Paterson, a Scottish clergyman, of fertile resources, and great political sagacity, the original designer of the Bank of England, conceived the magnificent design of establishing a colony upon the shores of Darien, based on principles of religious toleration and free trade, which, occupying the highway of commerce, "grasping the riches of both the Indies, and wresting the keys of commerce from Spain," should build up, on the shores of two oceans, cities surpassing his own Edinburgh, and rivaling ancient Alexandria. With experience drawn from long study and patient observation, he organized his scheme upon liberal commercial principles, and an enlightened political policy. Scotland, Hamburg, and Holland, contributed the sum of $4,500,000. This large amount surprised London merchants, and spread panic in the board of the East India Company. The unfriendly feeling of this great corporation proved, in the end, fatal to the scheme. Aided by Spanish intrigue, and Dutch rivalry, and bringing their vast machinery to bear against the colonists, by argument and misrepresentation, they induced William III. to issue an edict, forbidding all English colonies in the West Indies from sending provisions, arms, or ammunition to the Scottish colony of Darien.

Of 1,200 colonists, three hundred of whom represented the best blood of Scotland, thirty only returned to tell the story of their sufferings. Dissension, disease, and starvation, had accomplished the usual results. Thus, this design for the union of two great oceans failed; this effort to form a nucleus of a new system of beneficent wealth, and commerce, came to an untimely end.

The Caledonia Bay was no longer frequented by the ships of Eng-

land, Holland and Scotland. The gold mines of Cana, worked by one thousand men, under the Spanish domination, were destined to remain to the present day, unmolested. The north-western slopes, and the head waters of the Chuquanaqua, reverted to the undisputed possession of the Indians, while, between the lower part of this river and along the Savana, and the Bay of San Miguel, a mongrel population of 1,200 souls cultivate bananas, and impose upon strangers.

Dr. Cullen justly claims to have recalled public attention to the merits of this route. The fine harbors of San Miguel on the Pacific, and of Caledonia Bay and Port Escocés on the Atlantic, taken in connection with the narrowness of the Isthmus, would attract a casual observer. The favorable opinion of Humboldt has led many to look hopefully to this region. The advantageous situation of the Savana River was pointed out by Dr. Cullen, who claims to have "crossed, and recrossed, between Caledonia Bay, and Port Escocés alone, during the rainy season, cutting and marking his way with a machete. From the head of the Savana," he continues, "a ravine, three leagues in length, extends to Caledonia Bay, and there a canal might be cut with less difficulty than elsewhere, if it were not for the opposition of the natives. From the sea shore (at Caledonia) a plain extends to the base of a ridge, which runs parallel to the coast, and whose summit is 350 feet. This ridge is not quite continuous and unbroken, but is divided by transverse valleys, through which the Aglasenique and Aglatomente, and other rivers have their course, and whose highest elevations do not exceed 150 feet."

Impressed by these favorable representations, and believing Dr. Cullen's statement of the existence of large gold deposits near Esperitu Santu, and in the diggings of Veraguas, the distinguished capitalists, Sir Charles Fox, John Henderson, and Thomas Brassy, uniting with Dr. Cullen, obtained, by a decree of the Granadian Congress, dated Bogotá, June 1st, 1852, the concession of the exclusive privilege of cutting a ship canal across the Isthmus of Darien, between the Gulf of San Miguel on the Pacific, and the Bay of Caledonia on the Atlantic, with the liberty of selecting any other point on the Atlantic coast between Puerto de Musquitoes, and the west mouth of the Atrato, for the entrance of the canal ; and were granted, besides the lands necessary for the canal and its works, 2,000,000 acres of land, to be selected in any part of the Republic. All the ports of Darien were declared free and neutral.

Notwithstanding these favorable conditions, it was deemed prudent, by the distinguished capitalists above mentioned, to send out a com-

petent engineer to verify the statements of Dr. Cullen. Mr. Lionel Gisborne was selected for the purpose, and was accompanied by Dr. Cullen, to point out the way.

Before arriving in South America Mr. Gisborne, assuming the data supplied by Dr. Cullen to be correct, enters into some interesting speculations. "Let us suppose," he observes, "the summit level to be 150 feet above the level of the sea. The Atlantic rise of tide is only 3 feet (1′ 5″); that of the Pacific is 25 feet (22 to 23), therefore, the difference in the level, at high and low tide is 11 feet (this, although suppositious, will, I anticipate, not be far from the truth). In such a case I would propose to cut a canal through from ocean to ocean without any locks," etc.

Proceeding on the supposition of certain "circumstances likely to coexist in a country whose chief geological formation is igneus," he proposed a second plan. "By embankments placed in the most advantageous position" two lakes are to be formed upon each side of the ridge, which, being cut through, ships can pass from lake to lake, and lock down to either ocean from the opposite extremities. "The only objection" to this plan, is, he thinks, "the loss of land inundated." "I hope," he adds, "a tract of country will be found where one or the other of these cases is applicable." It is very remarkable that Mr. Gisborne found a country adapted to this plan.

This expedition was long delayed in Cartejena, awaiting Dr. Cullen, who was occupied with business connected with the survey before the Congress of Bogotá. "I determined to wait for the English mails," writes Mr. Gisborne, "due here the 25th, otherwise I should certainly not spend three weeks waiting for Dr. Cullen." On another day, "an instrumental survey," he prognosticates, "seems to be out of the question, so that our levels, theodolites, sextants, and chains, will probably remain in the same box Troughton and Simms consigned them to on our departure from England."

Again, "I have read and listened about Darien Indians, their cruelty and jealousy, until I am callous and unbelieving; but it frets me to remain in doubt, ebbing out an existence in Cartejena. I have determined," he says, "to wait ten days longer—then D. V. Cullen, or no Cullen, I shall try what can be done with these ungovernable Indians."

Waiting impatiently, he speculates upon the Aurora Borealis, geology, magnetic observations; ingeniously proposing, by the automatic action of appropriate machinery, to make all meteorological phenomena register its name and mission in a room selected for that purpose. This he calls a "meteorological loom in which the web of time is spun with the present for a pattern."

"May 29th—The Bogotá mail has come, but no letter from Dr. Cullen. Every thing here is manăna (to-morrow)."

He again takes to speculating on fortifications, and the beauty of the senoritas. A reasonable man would have been contented. But he leaves this primrose path to write, "Dr. Cullen has neither written, nor appeared in person, and I am beginning to have my doubts whether he will do so." In the meantime Cullen was hammering at the "manăna" Congress at Bogota.

After waiting six weeks he left Cartejena in disgust, and landed, without the indefatigable Doctor, in Caledonia Bay. Here he spent two days wandering among the hills with his barometer, his spirits going down as the mercury went up.

He was arrested by three half-naked Indians, who, in an unintelligible language, but plainly to be understood gestures, commanded him to follow. This he prudently acquiesced in, but not until he had, as he thought, ascertained the dividing ridge between the Atlantic and the Pacific to be 272 feet above tide. Falling asleep, with a contented mind, he thought he heard the roar of the surf of the Pacific, but his companion, Ford, very shrewdly suggested that they were still within hearing of the Atlantic. With a gentle admonition that they must never be caught there again they were permitted to return to their boat.

Naturally, he could not forbear another fling at the helpless Dr. Cullen. "I had not much faith in Dr. Cullen's map, as his descriptions of land south-west of Port Escocés were directly contrary to the fact."

The comment, on his failure may puzzle the reader. "I am far more satisfied at having failed in crossing from Port Escocés than to have crossed and returned (supposing that was possible with safety), and reported a summit 275 feet, when, within a few miles, one of 40 is to be got further inland."

"It is dangerous to argue by induction," observes Mr. Gisborne, and he gives 238 pages in illustration of this truth.

Nothing daunted by his failure to effect a transit from the Atlantic side of the Isthmus, he determines to proceed to Panama, and to make another attempt from San Miguel on the Pacific. Proceeding up the Savana river he disembarked with his Asst. Ford, who had charge of the mountain barometer, and penetrating two days' journey into the interior, he is warned by a *log over a stream* that he had reached the country of his enemies, the Caledonia Indians. Remembering their parting injunction he returned.

"A dreamy hope of success," he writes, "is strengthened by in-

ductive argument, the cause of former failures leads to generalizations of geological theories, and topographical analogy, and it was this conviction that cheered me under all difficulties, making suffering an indispensable appendage of success."

Consoling himself with such reflections he met Dr. Cullen at Panama, in high dudgeon. The Doctor reproached him with having broken his instructions, and required that he should return to San Miguel. Gisborne was recalcitrant. "Feeling satisfied that a ship canal could be made across Darien, he urged Dr. Cullen to come to England, and, as he said he was without money, I offered to advance the passage money."

This generous offer was accepted. Having found, as he believed, a summit of 150 feet above tide, corresponding with Dr. Cullen's statement, he submits two plans to his employers. One for a thorough-cut without locks; the other by the junction of two lakes, for which he had found a suitable physical conformity, in remarkable harmony with his prophetic speculations before reaching Cartejena.

The first plan was estimated to cost £12,500,000, or about $62,500,000.

The friends of the measure in London were elated by the representations of the expeditionists.

The Atlantic and Pacific Junction Company was incorporated by royal charter, or act of Parliament. The capital, limited to £15,000,000, was disposed of in shares of £100 each. A deposit of ten shillings on each share was to be made without further liability, forming a sum of £75,000 for preliminary expenses.

A provisional directory was organized, with Lord Wharncliffe as chairman. Upon the publication of their prospectus, a lively correspondence sprang up between the *London Times* and Sir Charles Fox. The writer of the *Times* is charged with want of appreciation of the merits of the Darien route, and retorts, that if no one is to question Sir Charles Fox's views, or even speak of their inaccuracies, there must be an end of discussion.

While this controversy was raging, another expedition was being organized, in numbers and appliances far exceeding any previous attempt, with the same object. England, France, and the United States coöperated with New Granada. Not since the landing of Paterson had so formidable an expedition appeared in that region.

When the Virago entered the Bay of San Miguel, the Scorpion and l'Espeigle, with Mr. Gisborne and Dr. Cullen on board, anchored in Caledonia Bay. The French ship, La Chimere, and the American

corvette, Cyane, Lieut. Strain, at the same time joined the expedition, raising the united crews to the number of 700 men.

The Granadian Government, in furtherance of the object of the expedition, had established a depot near the junction of the rivers Savana and Lara. It was confidently believed that the practicability of the Darien route was about to be set at rest forever.

Relying on Mr. Gisborne's and Dr. Cullen's reports, Lieut. Strain, with a party of twenty-seven men, two Granadian Commissioners, and ten days' provisions, pushed forward up the bed of the Caledonia River. Here, taking advantage of an opening among the trees, he examined, with a spy-glass, the range of Cordillera, to find a semi-circular chain 1500 to 2000 feet in height. He concluded that this route could not be that alluded to by Mr. Gisborne and Dr. Cullen. He still pushed forward up arduous ascents. A seaman of the Cyane climbed a tree to reconnoiter the country, and reported nothing but hills and mountains in every direction. For a pathetic account of this unfortunate expedition, the reader is referred to *Harper's Monthly*, Vol. X.

After forty days of wandering, subsisting for the time chiefly on sour palmetto berries, emaciated with hunger, lacerated with thorns, sick, and half naked, Strain, having hastened ahead of his party, sought succor in Yvisa. Proceeding to the Savana, he presented himself to the English agent, who, receiving him with every kindness, shed tears at the sight. Securing assistance, which was reluctantly granted, at Yvisa, he hastily returned to find the remnant of his party, feebly struggling back toward Caledonia Bay, having lost five of their number, among whom were the two Granadian Commissioners.

Strain, mistaking the Chuquanaqua for the Savana, reached the Pacific by the longest route. He claims that his expedition "has disproved a magnificent preconceived theory," and that instead of a summit-level of 150 feet, it is at least 1000 feet.

Three days after the departure of Strain, "another party, composed of English and French together, under the guidance of Dr. Cullen and Mr. Gisborne, set out from the same point, and endeavored to follow in his track." "Gisborne and Cullen could not follow their own maps," and after having "penetrated not more than six miles in all, returned." Mr. Gisborne, observes the narrator in the *Nouvelles Annales des Voyages*, "dementait complétement" his former statements. They failed to confirm the first statements, and the London company, organized with such high hopes, was dissolved.

On the heels of Gisborne and Cullen, the Granadian expedition,

under the command of Codazzi, made a cotemporaneous essay. "How far," says Strain, "it penetrated is not known; but, struggling over the space of a mile, it was broken up, and returned after having lost several men."

While failure and misfortune was befalling the exploring parties starting from the Atlantic coast, another attempt was made at the same time to effect a transit from the now notable Savana. Capt. Prevost, of the Virago, after advancing twenty-six miles, at the rate of one and one-half miles per day, returned again to the Savana, followed, says Mr. Gisborne, by two hundred hostile Indians. Four sailors, left to guard a depot of provisions, were found murdered.

Capt. Prevost failed to find a practicable pass. Crossing valleys which probably led to the Pacific, the altitude of which is not given, he terminated his survey at a summit of 1080 feet above the level of the ocean. "L'execution de canal interoceaneque était devenue á peu pris impracticable," remarks the reviewer.

After an examination of the maps of Gisborne, Prevost, Strain, and Codazzi, there seems to be a general agreement in placing the summit of the ridge at not less than one thousand feet above the level of the tide. The united maps of Prevost and Gisborne exhibit their routes, proceeding from opposite points and intersecting, and the continuous profile between the two oceans fails to solve the question of a practicable route. As one of these parties had the advantage of Dr. Cullen's personal guidance, it is but fair to allow him to supplement his first statement by an explanation of the causes which led to a failure so complete and unexpected.

Speaking of the party from the Virago, he observes that Capt. Prevost "directed his explorations too far to the north-west." That when it stopped he was but thirty miles from the point where the line should pass.

Strain, on the other hand, erred by going "too far to the south-west." In a word, the true line is to be found in the golden mean in which Aristotle places all virtue.

But he has so far modified his first statement that he now thinks a line, "with tunneling," may be found between Sucubti and Port Escocés. Under nine heads, he enumerates the advantages of this route.

The reader has, perhaps, concluded that, like Pantagruel's army, this subject is pretty well covered with tongue, and he may even adopt the conclusion of a distinguished attorney-general upon the fallibility of this unruly member. But one or two of the nine may be quoted. Under No. 7 Dr. Cullen states the land rises to nine

hundred and thirty feet, and that here a tunnel will be required. No. 8 states that between this point and the Pacific no obstacle is to be found. The divide of one hundred and fifty feet, first discovered by Dr. Cullen, expanded to ten times that altitude.

If men of intelligence and education can so err, all statements of persons whose previous habits and studies have not fitted them for passing judgment upon the relative merits of different canal routes should be received with caution.

The failure of this formidable effort of four Governments to discover a practicable route for a ship canal between Caledonia Bay and the Gulf of San Miguel, while it disappointed reasonable expectation, stimulated public curiosity. The French, in nowise discouraged, determined to make another effort. The Granadian Minister, Francisco Martin, and Senator F. Barrow, signed, at Paris, a treaty embodying certain concession.

According to agreement, the survey was to be conducted from the head of the Chuquanaqua toward the village of Monti, where Codazzi represented a summit of 460 feet.

M. Bourdiol, Civil Engineer, with a party of fifteen persons—afterward increased to twenty by the addition of some natives—proceeded carefully, cutting their way, and chaining and leveling at the rate of about a mile a day. Reaching the Chuquanaqua below the junction of the Sucubti, he was compelled to desist, by the approach of the rainy season. He returned to Panama after an absence of sixty days.

The nearest approach to a determination of a pass by M. Bourdiol appears in the rather equivocal statement, that the origin of the valley of Monti is one hundred and eighty-two metres (about 597 feet).

If all of these explorers had left some permanent mark at the termination of their surveys, succeeding parties could have taken up the line where the former left off, and the determination of a practicable route could have been made in one-half the time now required.

M. Bourdiol affirms that he verified the height of the Sucubti, as given by Codazzi and Gisborne, but it is not apparent how he found the same points determined by these engineers.

Where so many failed, with every accessory and advantage likely to assure success, the pertinent inquiry suggests itself, Is there any one fact in common which may serve to explain failures so universal? All find difficulties in cutting the way, requiring natives accustomed to the use of the machete; all are misled by imperfect maps, which fail to give the altitude of the passes and the true course of the rivers. While one party is turned back by the rainy season, another is stopped

by the Indians, another by want of time. But one party succeeded in crossing from sea to sea, but under such circumstances that each day was a struggle for existence, to the exclusion of the scientific objects of the expedition.

The hostility of the Indians, although not always stated, appears to have been the chief obstacle to a careful exploration ; and internal dissension concurred to bring failure upon the best appointed of these expeditions.

The following table presents, at one view, all that is known of the Darien routes :

NAMES.	LOCALITY.	SUMMIT REPORTED	REMARKS.
		FEET.	
Cullen	Savana, Port Escoces.	150?	"Crossed and recrossed?"
Gisborne	" "	150?	Saw across to former position?
Cullen	Started at Caledonia Bay.	980!	Second attempt and failed to cross over.
Gisborne			
Strain	Caledonia Bay.	1000+	Lost his way on the Chuquanaqua.
Prevost	Savana River.	1080	Did not see the Pacific.
Bourdiol	" "	597?	Turned back by rain.

It would appear, at the first glance, that the question of a practicable route across the Isthmus of Darien was settled by these explorers.* Dr. Cullen, notwithstanding the unfortunate result of his early prognostications, still remains sanguine, and opines that the valleys of the Aglatomente and Aglasenaca afford levels favorable to a canal ; but Gisborne's map represents the water-shed of the Aglasenaca at 1,020 feet above the level of the sea, and supplies no indications of a lower summit. But Capt. Prevost gives some important testimony. In a letter to Admiral Moresby, written after the return of his expedition, he speaks of valleys at a lower level than any yet discovered, leading to the Pacific. His map confirms this statement. Capt. Parsons, R. N., of the Scorpion, testifies to the same effect. From the deck of his vessel he could discern a very decided break in the ridge, which appeared continuous when viewed from other points.

These estimates we have learned to receive with caution. "A dreamy hope of success is strengthened by inductive argument," observes Mr. Gisborne, "the cause of former failures leads to generalizations," etc., and such faint lights have so far proved veritable will-o'-the-wisps. In the present instance, concurrent opinion is highly

* An announcement in the Cincinnati Commercial declares that the exploring party now at Darien have failed to find a practicable route at that point.—[May 11, 1870.

favorable. The appearance of isolated summits, and disjointed and dislocated character of schistose and trychitic rock; the testimony of Prevost and Parsons, to the appearance of a break in the ridge; the fact that Col. Hughes found at Panama a summit of two hundred and eighty feet above the sea, at two miles north of the line, upon which Garella could not find less than four hundred and fifty-nine feet above the same level; all these facts, if not "confirmations strong as proofs of Holy Writ," are more than "trifles light as air," and go far to confirm the opinion that the Isthmus of Darien has not been sufficiently explored.

SAN MIGUEL TO THE GULF OF URABA.

Sr. Gorgoza, a Granadian, represents that he has passed over this line, and found an altitude of one hundred and ninety feet. How this elevation was determined without a barometer or spirit-level is not clear. This part of the Isthmus is referred to in general terms by Humboldt, Fitzroy, and Trautwine, but as these authorities echo each other, the inference derives little additional strength from their concurrence.

ATRATO.

Taking leave of the Darien surveys, the explorations in the province of Choco come next in order. Under this head are included the surveys made in the valley of the Atrato. Success appears to have accompanied these operations, as disaster followed the Darien expeditions. The hopes centering in any one Isthmean route have been in the inverse ratio of the information concerning them.

The indispensable desiderata of a summit of moderate elevation, and deep harbors, have not yet been found existing conjointly together. The volcanic agency which hollowed out deep basins where ships may securely anchor, has, at the same time, given unusual altitude to the dividing ridge. Shallow harbors and low divides, and deep harbors and great altitudes, accompany each other with the persistence of a law.

As the explorations dissipated the hope of one route, another was taken up. Vague rumors continually reach us similar to those we have already encountered. One of the latest of these is this: A Mr. or Sr. Gorgoza, a resident of New Granada, has found a short and easy transit across the Cordillera, between the Gulf of San Miguel and Uraba (or Darien), by ascending the Tuyra, and crossing the valley of the Atrato. According to his statement, the depression in the divide is not more than 190 feet above the mean tide, and the dis-

tance between head waters, navigable by canoes, is not more than three miles.

DE LA CHARME ROUTE—BY THE WAY OF TUYRA, PAYA, AND CAQUARRI TO THE ATRATA.

The March number of *Putnam's Monthly* contains a description of a route surveyed by M. De La Charme, which occupies a position between the Darien routes, and the line between Humboldt Bay and the Atrato, surveyed by Lieut. Michler.

The article referred to gives an account of what appears to be the latest reconnoissance made in that region, and claims for its author, M. De La Charme, "the right of discovery." Of this survey Sr. De Gorgoza is the patron and prime mover.

The attention of Sr. De Gorgoza was called to this route by certain "documents" containing "hints about passages used by the Indians in crossing the Cordilleras." These documents consisted of "reports by the civil and ecclesiastical authorities about the province of Balboa, which was, at that time, of great importance, from its rich gold mines," and are probably as reliable as any other civil and ecclesiastical reports of the pious marauders of that period. These reports were accompanied by "a map," which seems, from a reference upon page 133, to have been that remarkable specimen of puzzling topography, known as Arisa's map, a copy of which may be found appended to the report of Admiral Davis. The usual reference is made to those unconscious pioneers of interoceanic canal routes, the filibusters, "who carried off quantities of gold, to the great detriment of the Spanish treasury," etc., etc.

This *reliable* evidence is further corroborated by the flight of birds. Some Pissisi ducks providentially appear to lead our explorer upon the right path, and M. De La Charme is so convinced that the route will be found in the direction taken by these web-footed engineers, that he confidently affirms "there remained to me no doubt but at this place I should find the desired passage. So persuaded," he "prosecuted his work with confidence."

Many immaterial facts are circumstantially related, but we are not told by what method the survey was conducted, nor whether M. De La Charme was assisted in his work by professional engineers. Without such assistance, his duties must have been complicated and laborious. As mention is made of bogas and laborers only, we must conclude that this arduous duty was performed without any intelligent assistance.

He states that strict attention was given to barometric measure-

ments. The notes should have been supplied in proof of the accuracy of his conclusions.

The irregularities of the barometer along the dividing ridge of the Isthmus and in South America have been noticed by Moro, Hughes, Herndon, Maury, Michler, and other observers. Used with extreme care, and according to the method recommended by Lieut. Col. Williamson, U. S. A., the results obtained with this instrument are affected by discrepancies and anomalies, which, along the Andes, vitiate the most careful observations, and elude the grasp of the best formulæ.

A favorable reconnoissance with the barometer, in this region, should receive a careful verification with more accurate instruments, but it can not be regarded as establishing the feasibility of a route.

The map of M. De La Charme, like that of Dr. Cullen, is made up from old maps. The additional topographical information is not laid down.

Two parties were sent to the Isthmus to verify this route. One, composed of French engineers, was under the charge of M. Flacat; the other, composed of American engineers, was under the direction of Mr. Spooner. With both the principals Sr. De Gorgoza quarreled, and the parties returned without accomplishing the work for which they had made so long a journey.

The following paragraphs contain all that M. De La Charme claims to have established. If correct, he is justly entitled to the right of discovery, in the furtherance of which claim "he considers it his duty to publish the present memorandum."

"This canal should go in a straight course E. 20° S. from Real Viejo to the village of Paya, thence south-east through the passage between the Cordilleras and the Andes, and, finally, easterly or north-easterly, as should prove best for the navigation from the Atlantic by the Atrato. It would not be more than fifty miles long, and would traverse a country whose formation presents no difficulties to the opening of the same, either in the excavation or in the removal of the materials excavated, an important point in works of this kind.

"The highest point or summit-level of the route thus explored was near the village of Paya. It was, by barometrical measurement, one hundred and seventy-eight feet (about 55 metres) above the level of the sea, and this must necessarily be very nearly the true altitude. And, it may be added, the field notes of the expedition contain satisfactory data respecting the questions of practical engineering involved, such as feeders, locks," etc.

So little accurate information exists in regard to the topography of the Isthmus, there is always a probability in favor of the discovery

of new routes. But the uncertainty which must attach to the sanguine representations based upon interested but unprofessional examinations, has been made sufficiently apparent. Such statements can not be accepted without verification. This is doubtless all that Sr. Gorgoza desires.

ROUTES OF PORTER, KENNISH, AND TRAUTWINE.

In July, 1857, the results of a survey from the Atrato to the Pacific, made by Mr. Kennish, under the direction of F. W. Kelley, were laid before the Secretaries of War and Navy. Mr. Trautwine had previously surveyed the Atrato from its mouth to its head, crossing the ridge in three places, obtaining much valuable information. Mr. Porter made a survey in 1853. The survey of Mr. Kennish, before alluded to, was made in 1855.

Commencing at the mouth of the Atrato River, the work to be done is described as follows: The mouth of the Atrato being obstructed by bars, the caño coquito, by which the river is to be united with the Gulf of Urabà, having at the present time a depth of four feet water, is to be excavated to a depth of thirty feet. From thence sixty-five miles to the mouth of the Truando, the depth is not less than forty-seven feet. The bar at the mouth of the Truando is eighteen feet. For six miles the river has an average depth of fourteen feet. From thence to the Pacific, twenty-six miles, much of the distance is through solid rock. At 505 feet above the ocean level, Mr. Kennish proposes to pierce the divide by a tunnel three and one-half miles in length, sufficiently large to admit two ships abreast.

The harbor at the Pacific terminus requires improvement; guard locks not considered necessary. Total length of the line, one hundred and twenty-six miles. The results of this survey were regarded as highly favorable by the friends of the measure.

Mr. Kelley regarded his labors and expenditures as well rewarded. "Franklin," he observes, "was not more delighted when he drew lightning from the clouds, nor Columbus when he discovered America, than I was when it was demonstrated, by instrumental measurement, that the two oceans could be united, that all the science, industry, enlightened enterprise, and generous expenditure had not been exhausted in vain."

To verify this survey, Congress authorized the Secretaries of War and Navy to organize a joint expedition. In accordance with this authority, the Secretary of the Navy designated Com. Craven. This gallant officer was afterward sunk off Mobile, and lost with all the crew of his ship.

MICHLER'S ROUTE.

To Lieut. N. Michler, Corps of Topographical Engineers, (now Brevet Brigadier-General,) the execution of the topographical survey was assigned. The operations of this officer were published in the form of a diary, with special scientific reports and observations, accompanied by maps and profiles. The special reports embrace observations upon geology, botony, hipsometrical and astronomical determinations, climatology, and field notes.

The itinerary is full and interesting, supplying information valuable to future explorers. The reader is never asked to accept a statement upon the *ipse dixit* of the writer. The observation of a corps of intelligent surveyors is laid before the reader.

The line adopted by General Michler may be described as follows: To avoid the bar at the mouth of the Atrato, a canal, about two and one-half miles, is to be cut through the channel of the caño coquito. The mouth of this caño is protected by nature from the prevailing winds. The Atrato affords navigation for the largest ships. The remaining part of the line is described in General Michler's words: "Let the first section follow the projected line referred to above, across the Lagunas to its intersection with the Truando; the second section connects this last point by a straight line with the head of the Palizadas; the third extends in a direct line to the foot of the Saltos; the fourth in a curved line to the head of the Saltos, including a tunnel of 800 feet through the Sierra de los Saltos; the fifth leads directly to the mouth of the river Grundó, a tributary of the Nercua; the sixth leaves the valley of the Nercua at the point by a straight line, perpendicular to the axis of the Cordilleras de los Andes, and, after piercing the mountains with a tunnel 12,500 feet in length, continues on to the mouth of the Chuparador; the seventh follows for some distance down the valley of the river Paracuchichí; and, lastly, the eighth strikes in a direct line for the Bahia Ensenadá, or Estero de Paracuchichí.

"The line proposed by Mr. Kennish differs very materially from the one just described. It leaves the Atrato at the mouth of the Truando, and follows the meanderings of the stream to its junction with the Nercua; it then ascends the valleys of the latter and of the Hingadór, and strikes across the mountains to the Pacific. The length of the cut by his plan is stated in his report to be 56.08 miles.

"In order to complete the line of canal communication between the Atrato and the Pacific, it is necessary to connect the Estero de Paracuchichí with Humboldt's Bay. It is proposed to do this by a

cut from the former across the peninsula, and then by building out in its prolongation, from the shores of the latter, jetties to form a passage through the surf into deep water of the ocean. The depth of the cut between them will have to be sufficient to allow for the swells of the latter, at least from thirty-five to forty feet below low tide."

To connect the Atrato with the Pacific by a canal without locks, there would be 95 miles of river navigation, and 52⅔ miles of canal, making an aggregate length of 147⅔ miles.

The following table gives the different items and the total cost of the work:

Interoceanic Ship Canal.

Summary of the estimated cost of the canal and appurtenances.

OBJECT OF EXPENDITURE.	ESTIMATE BY GEN. MICHLER FOR EXCAVATION AND TUNNELING.
Works at the mouth of the Atrato	$ 500,000
Excavation of earth	24,835,173
Rock cuttings	64,774,950
Tunneling	13,995,000
Pacific harbor improvements	1,150,000
Light-house	35,000
Piers	25,000
Depots on Pacific	50,000
Depots on line, and hospital	35,000
Depot at junction	15,000
Executive department	120,000
Engineer department	375,000
Medical department	80,000
Pay department	90,000
Commissary department	120,000
Quartermaster's department	135,000
Dredging machinery	350,000
Hoisting and pumping engines' machinery	875,000
	$107,560,123
Add 25 per cent. for contingencies	26,890,031
	$134,450,154

This estimate supposes the dimensions of the canal to be 100 feet wide and 30 feet deep. This rate ($2.50) per cubic yard is evidently too small. Estimating this tunnel at the contract price being employed ($5.40), the cost will be $30,229,200; and should the price reach the not improbable limit of $10 per cubic yard, the cost will be increased to $55,970,000. Substituting these sums in place of the cost of tunneling as given in the above estimate, and the total cost of the canal along this route will, in the first case, be $150,684,354, and,

in the second case, $176,625,154, which is not excessive, if the tunnel is to be lined throughout.

The Penaebach tunnel is the only one in England that is self-supporting. It is driven through solid basalt. The Penmaenwhr tunnel, pierced through hard green-stone, had to be lined throughout; and the Bangor tunnel, supposed to be sufficiently firm, was afterward cased with brick. It has been found necessary to line some of the tunnels of the Washington aqueduct, which are driven through very hard gneiss.

Before taking leave of this instructive report, we have selected some interesting portions of the narrative and scientific statements for quotation:

"The great falls of the Hingadór are grand and exceedingly romantic, and equal in height and beauty to many of those in other countries which elicit so much admiration from all lovers of magnificent scenery. The valley itself is pleasant to gaze upon; many bright streams gush into it, and impart additional charms to the already picturesque landscape of falls and rapids, and rich tropical vegetation. Several thermal springs were discovered at the foot of the great falls.

"As the party had to wade through the water, over smooth and slippery rocks, and clamber up steep precipices, it took four days to accomplish this section of the survey. Several fragments of rocks were broken off at the head of the falls for subsequent analysis. According to the report of the geologist, of which the following is an extract, 'the rocky falls were found to be overcoated with a light, shaly conglomerate of a cemented texture, and containing, imbedded in a calcareous matrix, coarse sand and gravel. Higher up, in one of the western head branches of this stream, a more consolidated semi-rock was noticed, containing copiously interspersed fragments of little shells. This rock seems also to be impregnated with carbonate of lime.'"

The character of the natives may be gathered from the extract: "January 30th, 1858—Whilst seated on the rocks overlooking the falls, and listening to the music of the roaring waters, as they rushed fiercely past, with an occasional anxious glance at the curve of the river above, in expectancy of the momentary appearance of the long-expected canoe, the attention was suddenly drawn toward a long line of Indians, men, women, and children, emerging from the trail over the Sierra. As they filed by, several familiar faces were seen, and a kindly nod of recognition given and returned. Each bore a pack, from the largest to the smallest; these rested upon the back, and

were supported by bands, composed of the bark of trees, which passed in front of the forehead. Most of their effects were packed away in baskets, made of bark of certain trees, and very neatly manufactured. They proved to be old friends from Tocome, and were *en route* to make a visit to one of their Tambos, on the Nercua. All fear as to moving ahead was dispelled at sight of them. After depositing their loads on the rocks, near the small haven, just above the falls, they all left again as quietly as they had come, in order to bring up their canoes over the Saltos.

"Whilst the members of the engineer corps were extremely anxious to discharge their duties accurately and faithfully, and to prosecute, in the most thorough manner, every conceivable examination which could, in the remotest degree, furnish additional information in reference to the great work upon which they were engaged; still, circumstances over which they had no control, such as their want of provisions, and the scarcity of money wherewith to purchase and renew even necessary supplies, compelled them to turn back from the Pacific, and leave unaccomplished the reconnoissance of both the Paracuchichi and Jurador rivers. To have rendered their labors complete these examinations should have been made in connection with their other most interesting duties. The future survey of these streams, and more especially of the former, together with that of the country, between its head-waters and those of the Pavarador, a tributary of the Nercua, and also between some of the tributaries of the Truandó and the coast, at some more southern point of Humboldt Bay, may throw a flood of light upon the feasibility of the work in contemplation."

He again expresses his regret that he was unable to extend his examination:

"It is to be greatly regretted that circumstances prevented the party from gaining more minute information concerning the valley of the Paracuchichi, and of the transversal passes leading from it through the mountains into the valley of a large tributary of the Truandó, which flows in only a few miles above its mouth. As this river has more than twice the quantity of water possessed by the Nercua, it is highly probable that a still more favorable route can be found leading out from its valley above the junction."

The following table of comparison between altitudes, determined by the level and by barometric observations, shows how much has been gained in accuracy, since the time of Humboldt, in the use of the barometer:

Table of data used in computing the various heights, with the results as compared with the heights obtained by the level.

STATIONS.	MEAN READING OF BAROMETER.	MEAN TEMPERATURE.	BAROMETRIC HEIGHT.	HEIGHT BY LEVEL.	DIFFERENCE.
	INCHES.	DEG.	FEET.	FEET.	FEET.
Sea coast	29.874	80.	.....	.....	.....
First camp on Truando	29.817	75.4	..... 58.39	44.57	+ 13.82
Tocame	29.805	76.8	..... 69.6	57.39	12.21
Foot of Saltos	29.759	76.1	..... 122.65	97.5	25.15
Observatory Hill	29.663	76.6	..... 207.45	204.95	2.5
Head Salto Grande	29.741	75.9	..... 132.3	138.79	— 6.49
Head of Saltos	29.737	75.9	..... 138.1	183.47	45.37
Junction of Rivers Nercua and Truando	29.674	77.	..... 192.5	192.6	+ 0.44
Tambo	29.607	77.	..... 260.92	264.4	— 3.48
First Ridge west of Rio Nercua.	28.815	75.2	..... 1,046.45	.....	.....
* Log Crossing on Rio Hingador, No. 1362..	29.053	75.2	..... 809.42	791.23	+ 18.19
* Log Crossing on Rio Hingador	.....	.....	Mean . 879.9	.....	.....
* Log Crossing on Rio Hingador, No. 1363..	28.912	75.2	..... 949.94	.....	.....
Camp on Hingador	29.074	75.2	..... 788.6	814.32	— 25.72
Dividing Ridge	28.913	75.2	..... 948.5	947.44	+ 1.06
Rio Chupepe	29.631	75.2	..... 240.24	241.35	— 1.11
Rio Totumia, below Dos Bocas	29.837	75.2	..... 40.6	45.3	5.24

These hypsometric determinations differ from the true levels at the points of observation from two to forty-five feet. These figures fall considerably within the limit of error considered as probable by Baron Humboldt. This distinguished observer states that the barometer may be trusted to determine heights to within from seventy-five or ninety feet of the truth.

* At this station the difference in the readings of the barometers was so great that the height was computed from the mean of the readings of each instrument separately. In other cases the united mean of both was used. The height given in the table was computed from the readings of the barometer which was used as a standard.

CHAPTER VII.

Physico-Geographical Features—Deficiency of Information—Barometer—Colonel Williamson—Lieutenants Gibbon, Herndon and Maury—Señor Moro—Popagayos—Influence of the Andes—Climate—Rainy Season—Colonel Hughes—Statistics—Population—Indians—Vegetation—Building Materials—Woods—Geology.

THE present chapter includes certain physico-geographical features subsidiary to the duties of the engineer and explorer. The object of this paper excludes all matter, not possessing practical value for this purpose, and admits of little more than mere mention.

The previous chapters indicate a deficiency in information in regard to the following routes:

1. Nicaragua—The practicability of a route between Monkey Point and the Lake Nicaragua, or San Juan River.
2. Chiriqui—No information extant.
3. Panama route, and improvement of the harbors.
4. San Blas and Chepo—A better line may be practicable.
5. Caledonia Bay, or the Gulf of Uraba to the Gulf of San Miguel, by way of the Savana or Lara Rivers.
6. Examination of the depression noticed by Gen. Michler.
7. The line proposed by Sr. Gorgoza.

The elevation of the passes upon these routes should be definitely fixed. The instrument which must determine the question of practicability is the Wye spirit-level. If the capacity of the harbors are insufficient for the largest class of ships, or can not be made available at a reasonable cost, further examination is unnecessary.

BAROMETER.

Notwithstanding the improved formulæ, and more careful method of observation recommended by Lieut.-Col. Williamson, Corps Engineers, the barometer is subject to peculiar and anomalous variations, along the slopes of the Cordillera of the Isthmus and the Andes. Lieuts. Gibbon and Herndon refer to this phenomenon. Lieut. Maury attributed the effect to the damming or piling up of the trade-winds against the mountains. A recent traveler in the valley of the

Amazon, I. Orton, observed the same phenomenon, but objects to Maury's theory.

Sr. Moro makes the following observations: "If, under these circumstances (prevalent winds), barometrical observations are made simultaneously on both sides of the Sierra, on the side of the Gulf, they will exhibit a lower elevation than the true one, the error being greater as that station may happen to be lower down or more towards the north; but if time should admit of waiting until the weather be equally fine on both sides (which seldom happens), then the difference between the levels of the barometrical columns is insensible."

Ventosa is peculiarly windy, and Nicaragua is subject to the Popagayos, a species of monsoon, upon the Pacific coast. But the more placid climate of the Atrato is similarly affected. "It is known as an established fact," remarks Capt. Kennish, "that the clouds seldom pass over the Cordillera toward the Pacific, but are attracted by the mountains, and disgorge themselves on the Atlantic side; hence the reason of the perpetual rain, thunder, and lightning in the Atrato Valley, while on the Pacific coast there is scarcely any rain for eight months of the year."

This unequal meteorological condition affects the barometer, and General Michler observed unaccountable discrepancies in the readings of two barometers when he reached the Hingador. With this exception, the results of this officer's observation were as close an approximation to the truth as can be expected in a reconnoissance, but it is impossible to say what given observation may be affected by some unknown cause.

A comparison of hypsometric determinations with the same altitudes, ascertained by the spirit-level, will furnish some important elements for eliminating errors. But this operation doubles the labor of the surveyor, and time and cost of his explorations.

The errors of the barometer have led to singular inferences, and the errors of observers to many more. Humboldt, La Condamine, Boussingault, give a decreasing pressure along the Andes; and Orton, taking this statement for granted, asks, "Are the Andes sinking?" The evidence of geological and historical periods is, that the Andes and sea coast are rising. The exceptions to this rule are local, and perhaps only in appearance.

These objections to the use of this instrument only apply to situations where the spirit-level can not be used. To determine heights inaccessible to any other instrument, or for simultaneous observation of the meteorological condition of an extensive area of country, the portability of the barometer render it invaluable.

The height of the barometric column, on the Pacific slope of the Andes, according to Orton, is 29.930. He gives two values for the Atlantic side, 29.997 and 29.932. Michler gives the Atlantic coast of the Atrato 29.874.

CLIMATE.

A well-defined rainy season prevails for the most part throughout the Isthmus, and permits the selection of suitable weather for the operations of the engineer. Rain varies with proximity to the mountains, etc., but the interval from December to May may be regarded as the dry season. The seasons are sometimes reversed, as in Costa Rica. There the dry season prevails upon the Pacific coast from November to April, but on the Atlantic the contrary prevails. Fall of rain in Honduras from May to October is 90.89 inches.

The tierras templadas, or elevated table-lands, are universally healthy, and the climate in those regions possesses a charm which belongs exclusively to the tropics. The unhealthy influences of the marshes and sea-coast is much exaggerated, and may be said to cease during the winter or dry season.

Col. Hughes, who visited the most insalubrious part of the Isthmus, remarks that travelers, "who live like civilized beings," have little to fear from the climate. The writer spent six months, chiefly near the sea-coast of Columbia, during part of the time compelled to sleep among the swamps of the delta of the Magdelina, and although exposed to the sun during the day, and sleeping in the open air at night, not one case of febrile sickness occurred in the party of which he was a member, nor were more than two cases of fever observed among the natives during the period of residence.

The temperature varies with the elevation above the sea. Thermometric records are of small value without the monthly and daily means of localities.

The following table may give some general notion of their range:

Fahrenheit.

	TEHUANTEPEC.	HONDURAS.	BALIZE.	COSTA RICA.	NICARAGUA.	ATRATO.
May	90°	71°	71°	57°	71°	Average during February 75.2
June	88°					
April	83°	to	to	to	to	
May	88°	89°	84°	85°	90°	
June	81°					
December and January	74°					

In Guatemala average maximum 88.7°. Minimum 38.9°.

Statistics, govermental and social, of Central America, are very uncertain. The revolutionary condition of a society, in which it is the interest of the chiefs to impose unjust burdens on the people, and of the people to deceive; where, before an enumeration can fairly begin, the government which authorized it may be deposed, and another substituted in its place; the poverty, anarchy, and social demoralization which result, are circumstances very unfavorable to a correct determination of the resources of the country, or the number of its population.

The following figures may not be free from this uncertainty, but give the best approximation that could be obtained:

Population of the States of Central America.

	SQUARE MILES.	POPULATION.
Tehuantepec	.....	61,000
Costa Rica	23,000	150,000
Nicaragua	48,000	290,000
San Salvador	9,600	294,000
Guatemala	43,380	907,500
Honduras	42,000	350,000
Panama, including Darien	.....	168,000
		2,220,500

This population is of a mixed character, composed of Europeans, Mestizoes, Indians, Negroes, and Zambos; the European element being largely in the minority.

INDIANS.

Explorers in every part of the Isthmus, with the exception of Darien, give favorable accounts of the temper of the natives. Trautwine, who crossed the divide at several points in the province of Chócó, regarded a bundle of cigars as the best passport. General Michler depended on the natives for provisions during a part of his survey, and was never disappointed.

But the Darien and San Blas Indians have been permitted to threaten and murder with impunity. They have been further emboldened by the timid behavior, and exasperated by the conduct of expeditionists. Had the hostile demonstration of the savages against Codazzi and Gisborne, and the massacre of four of Capt. Prevost's men, been promptly punished, subsequent exploring parties might now pass through the country unmolested.

Strain, who thoroughly distrusted them, acknowledges that in one case his suspicions were unjust. After dismissing his guides, he remarks that he "was afterward convinced that the Caledonia Indians, and their Sucubti friends, intended to lead them by the most direct route to the Savana, and that they were prevented doing so by the Indians of the Chuquanaque, or the Chuqunos, whom they met on the seventh day's march, and whom from the first excited suspicion." It would appear that this unfortunate expedition would have been better served by a little more confidence in these "formidable Indians," as Gisborne calls them, and a little acquaintance with their language, than by the fortitude it afterward exhibited in encountering the trials which befell it.

When misfortune appeals so strongly to sympathy, as it does in this case, criticism becomes an ungracious task. Throughout this paper we have omitted much in observing the rule, laid down for ourselves, to indicate what should be done, rather than notice what should not have been done. We therefore quote with pleasure the following graphic account of the difficulty of cutting a way through the tropical undergrowth, which we find in Mr. Gisborne's narrative:

Cutting the way, "we were wading along the river margin, or facing clusters of prickly stems sometimes backing this mass of vegetation. Every step had its difficulty, and every difficulty was attended with additional bodily suffering; but our hearts nearly failed when an interminable mangrove wood extended as far as the eye can reach.

"The twisted and interlaced roots, some eight feet high, grew out of a bed of slimy mud, left by the tidal waters, making progress a succession of gymnastic feats, in which the gift of balancing had no small share. Hand and foot were equally occupied, and every muscle was called into play; nearly an hour's perseverance had only advanced us a few hundred yards."

Another description of the same character will exhibit some of the difficulties: "Occasionally a swamp, growing an impenetrable mass of vegetation, delayed our progress and expended our energies in fruitless hacking. The only way to get through many of these cienegas was to fall on one's back into the middle of the matted vegetation, and then compress a place the length of one's self, which those behind trod down. After persevering in this manner for several hundred yards, an inlet would be reached with a soft, muddy bottom, and waist deep from the flood. On the other bank, the same mode of progress had to be adopted, until prickly palms, and still more prickly creepers, made a variety in the difficulty and suffering."

Strain met with similar obstruction. "Hitherto, Strain had led the party, every day cutting a path with his cutlass. This was most laborious, and Mr. Truxton insisted on going ahead in his place. The undergrowth was exceedingly dense, and composed, for the most part, of 'pinello,' or little pine, a plant resembling that which produces the pine-apple, but with longer leaves, serrated with long spines, which produce most painful wounds, especially as the last few days' march had stripped the trowsers from many of the party."

The best way to clear these obstructions has been found to employ natives, with machetes. This method, invariably adopted in Central America, has been recommended by Admiral Davis, who also advises the explorer to carry with him a good supply of canned and concentrated provisions.

BUILDING MATERIAL.

Suitable stone is found without difficulty. Hydraulic cement will probably have to be imported, although hydraulic limestone is said to have been found in the States of Vera Cruz and Oazaca.

The explorer will find difficulty in discovering building sand. The sea beaches may afford suitable sand for hydraulic work. Bricks can be manufactured, without difficulty, at many points.

WOOD AND TIMBER.

The following, from the account of Lloyd and Sidell, gives the local names and character of the most useful species:

1. *Guachapali.*—Abundant; four or five feet in diameter, like walnut; good under water.

2. *Macano*, or *Cacique.*—Crooked, medium size; good in ground or water; much used.

3. *Espino Amarillo.*—Not abundant; good in water; yellow; not liable to decay, or to be attacked by insects; straight; easily worked; seven kinds.

4. *Cedro Espinoso.*—Large, straight, light; heart alone good in open air and under ground.

5. *Cedro Cerollo.*—Large, crooked, durable.

6. *Cedro real, Amargo.*—Finest cedar of the country; used for many purposes in carpentry and boat-building; grows to five or six feet in diameter, and is very common.

7. *Nispero.*—Large; not easily worked; stands well when sheltered; insects do not touch it; resists transverse strain; two kinds much esteemed.

8. *Guayacan*, or *Guallacan* (*Lignum vitæ*).—Common; close-grained; heavy; works well when green; grows to four or five feet in diameter; used for gun-carriages, wheels, etc.

9. *Algarobo.*—Excellent wood; hard and tough; reddish brown, with streaks; large; common; used for gun-carriages.

10. *Mangle Caballero* (*Mangrove*).—Good as the Nispero; abundant near water; gives pieces thirty to forty feet long, and one foot square; used for vessels.

11. *Alcomorque* (cork tree).—Supplies large beams, which wear well.

12. *Malvicino.*—Yellow; abundant; wears well; employed in building.

13. *Caoba* (mahogany).—Large; not heavy; good for interiors; if not properly seasoned, is brittle.

14. *Robles.*—Large; not heavy; easily worked; used for paddle by the Indians; stand well in air; two varieties, one not good.

15. *Cocobolo Prieto.*—Tough, hard; beautifully figured (like rosewood); three feet in diameter; fragrant when green; used for carpentry and cabinet work.

16. *Tutumia* (calabash tree).

17. *Cano Blanco.*—Cane; good for lathing when split.

18. *Quira.*—Tough, close-grained, heavy; different colors, from light brown to very dark; very high; from one to three and one-half feet in diameter; plentiful; used in house-building.

19. *Madrono Fino.*—Like box; one and one-half foot in diameter; excellent wood for turning.

Mr. Loyd gives a list of ninety-five varieties of woods, of which list the above are the most valuable.

GEOLOGY.

A mere enumeration of the geological specimens, which is all that present knowledge upon this subject will permit, is not thought desirable in this paper. Speculations and theories, if not premature, would be out of place.

The physical geography of Central America is the proper subject for a treatise. We have already seen how the table-lands of Guatemala, from four to five thousand feet above the level of the sea, sink to an insignificant height at Panama and Nicaragua. "There is no spot on the globe," says Humboldt, "so full of volcanoes as this part of America, between 11° and 13° of latitude."

Two or three volcanoes, Fuego and Agua, in the State of Guate-

mala, are 14,000 and 12,000 feet high. Some of the volcanoes of Nicaragua reach a height of 7,000 feet. A common and remarkable characteristic of all of them is, that they rise in a conical form from the plain.

Gold and silver produce of Central America.

	GOLD.	SILVER.	BOTH METALS.
1804 to 1848	$8,800,000	$4,400,000	$13,200,000
1848 to 1868	5,000,000	3,000,000	8,000,000
Total	$13,800,000	$7,400,000	$21,200,000

The mines of the Provinces of Panama and the Veraguas are not worked so extensively as they deserve to be. A small quantity of gold is annually produced in the Republics of Nicaragua, Honduras, Costa Rica, and San Salvador. The Costa Rican mint, in 1852, coined between fifty and one hundred thousand dollars annually. The actual gold product is estimated at ten times this amount. The most important mines in new Granada (Colombia) are found in the State of Antioquia. In 1868, the yield was $1,500,000 gold; $193,000 silver. The detritus of all the rivers of this State is auriferous. An English company works the Marmato gold mine and the Santa Anna silver mine, near Honda, on the Magdelina River. They have provided twelve stamping mills, representing one hundred and ten heads, which crush from ten to nineteen thousand tons per year, yielding, on an average, eleven pennyweights eleven grains of gold per ton.

IS A SHIP CANAL PRACTICABLE?

NOTES,

HISTORICAL AND STATISTICAL,

UPON THE PROJECTED ROUTES FOR AN

INTEROCEANIC SHIP CANAL BETWEEN THE ATLANTIC AND PACIFIC OCEANS,

IN WHICH IS INCLUDED

A SHORT ACCOUNT OF THE CHARACTER AND INFLUENCE OF THE CANAL OF SUEZ, AND THE PROBABLE EFFECTS UPON THE COMMERCE OF THE WORLD OF THE TWO CANALS, REGARDED EITHER AS RIVALS, OR AS PARTS OF ONE SYSTEM OF INTEROCEANIC NAVIGATION.

BY

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ILLUSTRATED WITH MAPS.

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