# LETTER

IN ANSWER TO

# THE HON. JOHN M. CLAYTON,

SECRETARY OF STATE,

ON

# INTER-MARINE COMMUNICATIONS:

BY

BREV'T LT. COL. GEO. W. HUGHES,

*Corps of Topographical Engineers.*

WASHINGTON:
PRINTED BY JOHN T. TOWERS.
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Since the publication of the following Communication, in the National Intelligencer of the 22d and 24th November, 1849, it has undergone some slight verbal corrections, and a few unimportant additions have been made to it.

*March 4th*, 1850.

*From the Secretary of State to Col. Hughes.*

DEPARTMENT OF STATE,
WASHINGTON, *September 4th*, 1849

COL. GEORGE W. HUGHES,
*U. S. Tographical Engineers.*

SIR: In the conversation I had with you last evening on several topics of deep concern to the present and future interests of our country, I was struck by your judicious and intelligent observations on the subject of the various routes for connecting the Atlantic and Pacific Oceans, which have so long been discussed before the world, and which have now assumed an extraordinary importance. The subject is one which attracted my attention twenty years ago, since which time it has never ceased to occupy my mind; and I have neglected no occasion of seeking from well-informed persons accurate, reliable, and useful information in regard to it, such as might be calculated to diffuse light among our citizens, and serve as a safe guide to the public councils of the nation. With these objects very much at heart, I made a verbal request that you would do me the favor to address a communication to me upon the points we conversed about, entering fully into the questions they involve, and giving in detail your views and opinions thereon, and the considerations and facts upon which they are based, and presenting such information and suggestions as your experience and knowledge will enable you to submit.

Your attention is specially invited to the importance of a ship-canal, of such dimensions as to admit vessels of the largest class, connecting the Atlantic and Pacific Oceans; and you are requested to state whether there is reason to believe that such a route or routes may be found across the American Isthmus, and if so, where?—the length, capacity, supply of water, dimensions, and probable cost of the construction of a work on the most eligible line that is known to exist, best calculated to subserve the great ends of commerce of the civilized world, and of the present and prospective trade of the Pacific and Indian Oceans.

You are also requested to present your views at large in reference to the different projects which have been presented to the public for a railroad from the Mississippi to the Pacific, exclusively within the territories of the United States; and you will be pleased to submit all the information you may have been able to collect touching this important question.

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Would it not, in your opinion, be very important to the United States Government, to cause a careful scientific survey to be made of the Nicaragua route?

I am, sir, very respectfully, your obedient servant,

JOHN M. CLAYTON.

## *Col. Hughes to the Secretary of State.*

WASHINGTON, *October* 25, 1849.

*To the Hon.* JOHN M. CLAYTON,
*Secretary of State:*

SIR: In reply to your letter of the 4th September last, requesting my opinion in reference to the various proposed intermarine communications between the Atlantic and Pacific Oceans, I have the honor to submit the following paper:

The dangers, difficulties, and delays attending the voyage around Cape Horn, and the peculiar configuration of the American Isthmus, offering to the eye extraordinary facilities for establishing a safer, less expensive, and more rapid communication between those great seas, naturally suggested, at an early period after the discovery of the Pacific, in the year 1513, by Nunez de Balboa, the project of an artificial communication from ocean to ocean. This grand idea has acquired additional interest since the revolution of Spanish America, which has thrown open the trade of that magnificent country—rich in agricultural productions and mineral wealth—to the civilized world; and this interest has been greatly excited by the introduction of *oceanic steam navigation*, the increase of East Indian commerce, and the acquisition of California by a race rapidly developing its immense resources. The time seems at last to have arrived when the commercial world, and the civilization of the nineteenth century, call imperatively for the realization of this long-cherished object. There is no nation so deeply interested in it as our own, for it is emphatically an *American work;* and it is a matter of congratulation that one who has held and who holds so high a position, and exercised so powerful an influence in our public councils, as yourself, should so long since have called the attention of the Government of the United States to this subject, and should still continue to encourage its execution.

When we consider the remarkable progress which has been made, especially during the present century, in facilitating commerce, opening new means of communication, and prosecuting geographical researches in almost every portion of the globe, and reflect upon the long period in which the connexion of the Atlantic and Pacific Oceans has been agitated by Governments and scientific men, it is a source of wonder and astonishment, as it should be of humiliation and regret, that we possess so little exact and reliable information on the subject. Few scientific observers have traversed the American Isthmus, and with the exception of a single route, (and that we owe to the enterprise and munificence of an association of American gentlemen,) but little data have been collected on which to found the plans for an actual work. The elements which are essential for the digesting of such a project, the minute levels and topography, the geology and meteorology, the soundings of the rivers, lakes, bays, and harbors, and the guaging of the streams, are, with the exception already made, either entirely wanting or extremely defective. It is true that some

levels have been determined by the barometer, but no survey conducted on such a principle is calculated to convey an adequate idea of the difficulties to be encountered, or of the quantity of work to be executed; and can only be regarded as a better kind of topographical reconnoissance.

Baron Von Humboldt appears never to have visited the isthmus, and the scanty information he has published was derived from other and less careful explorers, who seem to have adopted vague generalities and popular notions, rather than sound philosophical theories, based on instrumental observations, on which alone we can safely rely. Even the illustrious savans, La Condamine and Ulloa, who sojourned three months in the vicinity of Panama, (after having crossed from the mouth of Rio Chagre to the Pacific,) failed to ascertain the height of the dividing ridge between the oceans, and added but little to the unsatisfactory results of Dampier and Wafer; and, in fact, the problem of the actual summit or lowest depression of that ridge remained undetermined until the present year, although it had afforded a fruitful subject of discussion for more than three centuries, and the feasibility of connecting the oceans depended on its solution.

As it regards the vast importance of an intermarine communication across the American continent, and the immense results to be produced by its completion, I shall offer no observations, from the persuasion that it is a matter now fully understood and universally appreciated. I cannot, however, resist the desire of presenting the following remarks of the Edinburgh Review on this most interesting subject:

"We are tempted to dwell for a moment upon the prospects which the accomplishment of this splendid but not difficult enterprise opens to our nation. It is not merely the immense commerce of the western shores of America, extending almost from pole to pole, that is brought as it were to our door; it is not the intrinsically important, though comparatively moderate branch of our commerce, that of the South Sea whalers, that will alone undergo a complete revolution, by saving the tedious and dangerous voyage round Cape Horn. The whole of those immense interests we hold deposited in the regions of Asia, will become augmented in value to a degree which, at present, it is not easy to conceive, by obtaining direct access to them across the Pacific ocean. It is the same thing as if, by some great revolution of the globe, our eastern possessions were brought nearer to us. The voyage across the Pacific, the winds both for the eastern and western passage being fair and constant, is so expeditious and steady that the arrival of the ships may be calculated almost with the accuracy of a mail coach. Immense would be the traffic which would immediately begin to cover that ocean, by denomination Pacific. All the riches of India and of China would move towards America. The riches of Europe and America would move towards Asia. Vast depots would be formed at the great commercial towns, which would immediately arise at the two ex-

tremities of the central canal. The goods would be in a course of perpetual passage from one depot to the other; and would be received by the ships as they arrived, which were prepared to convey them to their ultimate destination."

Nature has clearly pointed out the long and, in many places, narrow strip of land, which may geographically be called the "*American Isthmus*"—and I wish to consider it as a whole—connecting North and South America, as the region of country offering the greatest facilities, and interposing the fewest physical difficulties for establishing the oceanic communication now under consideration. It is there that we must look for the most equable temperature, for the shortest line, and the least elevation above the level of the tides between the arctic circle and the Strait of Magellan. I shall therefore avoid all reference to projected routes south of the Gulf of Darien. This great isthmus, of variable width, may be defined as extending from Tehuantepec to the Gulf of Darien, stretching from latitude 16° 30′ N. to 8° N., and from 95° of west longitude to 77°. This designation also includes what is termed the "Isthmus of Darien," extending from the Laguna Chiriqui to the Gulf of Darien on the Atlantic, and from the Gulf of Dulcé to the Gulf of San Miguel on the Pacific, trending in its general course nearly due east and west from the Gulf of Darien to the Gulf of Dulcé, between 77° and 85° of longitude west of Greenwich. Its narrowest part from tide-water in the one ocean to tide-water in the other, (less than thirty miles,) being from the Rio Chagre to the Rio Grande, near Panama.

It was supposed, until Mr. Hopkins showed the contrary, that the Cordilleras, or "the great back bone" of the western continent, extended, uninterruptedly, through the whole of North and South America, being simply greatly depressed on the Isthmus of Panama. But it is now certain that no such continuity exists. The Cordilleras of the Andes terminate at Darien, and the great North American range probably commences near the Isthmus of Tehuantepec.*

The two continents, as they formerly existed, are now connected (according to Mr. Hopkins, and confirmed by my personal observations,) by a series of uplifted hills of variable height, forming a not well defined, sinuous and contorted ridge, dividing the waters of the Pacific from the Atlantic, curving through the Isthmus of Panama in the form of an arc, "the convex surface of which faces the north; the easterly portion runs in a southeasterly direction towards Darien, and the southwestly prolongation extends to the shores of the Pacific, from whence it takes a westerly turn towards Veragua." Upon the slopes of this ridge, and often towering above it, are seen isolated conical hills, sometimes connected with each other, or with the dividing range, by

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* In 1823 the Prussian geographer Berghaus, contested the opinion of the continuity of the Cordilleras across the American Isthmus, a fact of which I was ignorant when the above was written.

low ridges of land. Nearly the whole of this formation is obviously recent, and of igneous origin. It consists of porphyry, greenstone, columnar basalt, hornblendic and trapean rocks; altered limestone and granites, changed from other rocks by the action of fire, also occur. A considerable variety of minerals are found, such as ores of copper and iron, agates, chalcedonies, and carnelians; and gold has been discovered in almost every stream, especially on the Atlantic slope; and indeed it is not improbable, from the many favorable indications of its existence, that the mines of this precious metal may prove, on further examination of the country, to be of great value. Very rich specimens of native silver have been brought to me from the vicinity of Gorgona.

Where sedimentary rocks are found, it is obvious that they are of still more recent origin than the igneous formations, and have been deposited since the upheaving of the latter, as they abut upon them, without disturbance of their strata, which are perfectly horizontal. Mr. Garella mentions some exceptions to this rule, but they escaped my observation.

It is almost impossible to resist the conclusion, forced on the mind, that at no remote period the two Americas were completely separate,* the ocean flowing (as it now does through the Strait of Magellan) freely and uninterruptedly between the continents, and occupying nearly all the space included between Tehuantepec and Darien, constituting in fact but one isthmus, although known by different designations. On the highest peaks, which have been simply elevated by interior force, marine shells of recent origin are frequently found.

As early as the year 1528 the attention of the Spanish Government was directed to the construction of canals over the following routes, viz:

1st. By the way of Lake Nicaragua.
2d. From the Rio Chagre to the Bay of Panama.
3d. From Nombre de Dios to Panama.
4th. Across the Isthmus of Tehuantepec.

And in 1800, from the Rio Grande near Panama, to the Rio Chagre, and from the Rio Caimeto, which flows into the Bay of Vaca del Monte, to the Rio Trinidad, an affluent of the Rio Chagre.

Many of the lines across the isthmus which have been suggested by Humboldt and others are now known to be utterly impracticable for canals, and as offering no inducements for the construction of other than common roads, possessing merely a local interest; and I have therefore not thought it worth while even to take them into consideration.

The following list enumerates all of the projected routes across the American Isthmus, which, according to our present informa-

* Mr. Garella expresses the same idea, and thinks that the mountains in which the rivers Chagre and Trinidad have their sources were formerly the extremities of the two continents of America, or were perhaps (which is more probable) large *islands* in a vast *strait*.

tion, promise any moderate degree of feasibility for the construction of either railroads or canals.

1*st. Tehuantepec ; 2d. Nicaragua ; 3d. Veragua ; 4th. Panama ; 5th. The Atrato at Darien.* It may not be inappropriate to remark in this connexion that a *plausible* route for a canal has been suggested in the province of *Choco*, where, according to Alcedo, the small ravine of Raspadura unites the neighboring sources of the Rio Noanama and the Rio Quito. This stream, with the Andageda and the Zitera, form the Atrato, flowing into the Atlantic, while the Noanama discharges into the South sea at the Bay of Choco. In the year 1788 the priest of the village of Novita employed his flock to dig a small canal in the ravine of Raspadura, by which in the rainy season, canoes pass from ocean to ocean, 225 miles distant from each other. This fact has induced many persons too hastily to arrive at the conclusion that this line is highly favorable for the construction of a ship canal, and yet nothing may prove more delusive. What is the height of the province above the tides? What would be the length of the summit level, and can an abundant supply of water be brought into it? What would be the probable cost of a ship-canal there 225 miles long? To these questions no answers can be given. The short portages or *embarcaderos** as they are called, which are found in so many passes of the dividing ridge on the isthmus, are well calculated to lead persons, not professional engineers, to very erroneous conclusions. As, for instance, in the rainy season canoes may be taken from the Atlantic up the Rio Chagre, and its tributary the Obispo, to Panama by the Rio Grande, with a portage of only *five miles*, and I have seen an iron-boat of 800 pounds weight carried in the *dry season* from Gorgona, on the Chagre, to the Rio Grande, and yet nothing could be more fallacious than the idea that this is a *practicable* much less a *favorable*, route for a ship canal. The truth is, that *all* the streams on the isthmus fall with great rapidity near their sources, and becomes very sluggish near their mouths, and in the dry season discharge scarcely any water until they reach the low levels where they are mainly supplied by percolation. These remarks are of general application, and I have selected the Raspadura as an illustration for the purpose of correcting any wrong opinions which may have been formed from the statement of similar facts.

I shall now proceed to the consideration of the different routes, before mentioned, in the order they have been enumerated, and shall endeavor to extract from the mass of vague, intangible, and often contradictory information, (the accumulation of centuries,) enough to form an opinion of their probable adaptation to the ends proposed, and, avoiding all mere speculations, to enable me to treat them, as far as our data will permit, as strict professional questions.

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* The word *embarcadera* literally means a landing or embarking place, but is usually applied to a portage, which may be supposed to include the other.

## 1st.—ISTHMUS OF TEHUANTEPEC.

So much has been recently published on this route, either from the direct observation of the writers or from the labors of others, that I feel there is but little for me to do without trenching upon the ground already occupied by persons more competent than myself to do it justice, except to present a *résumé* of the facts which have been collected, and a statement of the conclusions which I think may be fairly deduced from them. Those who may desire to look further into the subject are referred to the writings of Humboldt, Cramer, General Orbegozo, Moro, Col. Abert, and Lieut. Maury. The whole question was treated with great ability in No. 108 of the Union of 1847, in which a very fair and careful analysis of Moro's survey was presented. This survey, or rather reconnoissance, is the only one of the isthmus that has any pretension to a scientific character, and that is defective or rather deficient in many essentials. Col. Abert, Chief Topographical Engineer, in speaking of it, in 1847, remarks:

"The survey of the route, under Garay's grant, was made in 1842–'43, under the direction of the Engineer Moro, assisted by several others named in the report of his operations, which report was printed in London first, we think, in 1844; but the edition which is the basis of our present remarks is of 1846. It was certainly a survey, but rather of that character which may be classed as an instrumental or scientific reconnoisance, adapted to determine the bare practicability of the question at issue, but without that exactness which justify plan or estimate, the tracing of the route, or a reliable statement of its probable cost. The eye and judgment of the engineer, with a few points determined by the barometer, have been considered sufficient to indicate the line of feeder to the summit level, from which the practicability of distributing the water in the two directions could readily be decided. We admit that these data are sufficient to justify an opinion that a canal is practicable; but they are not sufficient, in our judgment, to determine what kind of canal, that is, of what dimensions, can be made, or its probable cost. We, therefore, think the plan of canal and the estimate of the engineer Moro rather premature, and we doubt if he will be able to sustain either of his views on these points, even by the facts of his own report."

Very little reliance for any thing but approximate results can be placed on the barometer, unless the most favorable conditions unite for the observations. Of this Mr. Moro seems to be perfectly conscious, for he remarks:

"The north wind, which frequently blows over the isthmus, brings with it the clouds formed in the Mexican gulf, and these are discharged upon the low grounds of the Coatzacoalcos, towards the northern side of the Sierra and its principal summits, whilst above the opposite slope and over the plain, which extends from the foot of the mountains to the shores of the Pacific, the

sky remains constantly clear. If, under these circumstances, 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 the 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. Hence we are unable to give the altitudes of *many places where observations were made*."

Certain it is that the barometer is a very unsafe guide in so delicate an operation as that of tracing a *feeder-line*, on which the practicability of a canal must depend; or the digesting of a projet for a railroad, as it does not determine the elements necessary to arrange the curvatures and gradients, or to calculate, even approximately, the cost of construction. For these purposes, corrected profiles, made from the results of continued *spirit level* observation may be regarded as absolutely essential. And all surveys for canals or railroads, not conducted with the spirit level, must be considered as imperfect, as they certainly are unsatisfactory. There is no other means that I am aware of, by which we can attain the required detailed information. It is in no unkind spirit of criticism, or of fault-finding with the engineer who superintended the surveys, that I make these remarks; but from a sense of duty to point out what I think to be defective in the survey. The map is, no doubt valuable, and will be found useful in future surveys, and many important facts have been ascertained; but it is the want of minute information to which I think it objectionable. In consequence of this it is almost impossible to form an opinion of the scheme beyond its general practicability.

The route proposed by Mr. Moro is from the Gulf of Mexico to the Pacific. The Gulf of Mexico port is the river Coatzacoalcos, the Pacific port the bay of Tehuantepec. We have no reliable information that the river bar on the gulf side will admit generally of more than twelve feet water, but at times fourteen feet of water may be carried over it. After passing the bar there is good water up to the foot of Tacamichapa island, and the river, after passing the bar, affords the most secure harbor. The length of the river to the foot of the island just named is about twenty-five miles; eight feet of water can be carried to the foot of this island, and ten feet to the mouth of the Coachapa, about seven miles below the island. From the foot of this island the mouth of the Malatengo is about ninety miles, by the course of the river. From this point, namely, the Malatengo, where it is generally admitted that the use of the river must cease, and a canal to pass the summit be commenced, the river has many shoal places, not exceeding eighteen inches, which admits of as good a navigation as that of the Ohio at low water. It would probably be better to canal the whole of this distance, using the river merely as a feeder.

The depth of the water over the bar, and the depth which can be carried up to the island Tacamichapa, or to the river Coachapa, plainly indicate the only kind of canal which should be made, namely, a boat canal, six feet deep, as there must be a transhipment of freight from sea-going vessels at the entrance of the canal. A canal would probably cut off many bends of the river, and be shorter than the river route. It would also have to be raised above the immediate valley of the river, in order to avoid its freshets, which are frequently as high as thirty-five feet. From the mouth of the Malatengo to the point indicated for the summit pass of the canal would probably involve a trace of not less than twenty-five miles, and from thence to the lagoons of the Pacific would probably involve a trace of about thirty miles. On these lagoons the transhipment from the Pacific would have to be made. They are large and deep masses of water, and would involve a navigation of about fifteen miles, to the Boca Barra, by which the communication is accomplished with Tehuantepec Bay of the Pacific. This Boca Barra has a shoal on its inner side of about eight (English) feet, and the passage to the Bay of the Pacific is very narrow, subject to violent currents in and out; and the Bay of Tehuantepec is an open roadstead, without shelter, and is represented as shoal for a considerable distance from the shore; it is also subject to extremely violent winds. The Boca Barra can hardly be considered accessible to sailing vessels, occasions would be so rare in which vessels of that kind could pass through it. It is no doubt more manageable for steam. The supply of water at the summit is very doubtful; and the most favorable view of facts which have come within my knowledge is that there might be water enough for a common (six feet) boat canal. Expensive reservoirs in the mountain gorges would ensure a supply of water for such a canal.

A railroad is, without doubt, practicable, and would be much less costly than a canal. There is no reason to believe that any extraordinary physical difficulties will have to be encountered in the construction of a railroad on this route; but we have no information to show what difficulties or facilities may be presented by the natural features of the country, or with what gradients the elevation of the summit may be overcome. It has been supposed that the railroad, if constructed, will probably pass through *Chivela*, as affording more space for the developement of the line, thus surmounting the dividing ridge with lower grades. Mr. Moro says that, *Tarifa* is less elevated than Chivela, but does not state the difference. We have absolutely no information from which to form an opinion of the magnitude of the bridges on this route, although building materials of wood and stone are undoubtedly abundant, and it is believed that subsistence for a large laboring force may be procured on the isthmus, or from the adjoining provinces. It is also supposed that a considerable laboring force may be obtained from the native population; but the *mechanics* will have to be imported either from Europe or from the United States.

Mr. Moro states the elevation of *Chivela* at 682 feet. General Orbegoso makes the same point 782 feet high, a difference of 100 feet. The lowest summit will probably be found at or near the Portillo or gap of Tarifa.

The summit pass is said to be 660 feet above tide, or general ocean level. From this elevation the line would have to be extended on one side about one hundred and fifteen miles, and on the other about thirty, to reach the navigable waters at each end, which would make the railroad trace 145 miles.

The whole distance from ocean to ocean by this route would then be about 185 miles, comprehending railroad, river navigation, and lagoon navigation.

In 1842 the Mexican Government granted the right of way for a canal or railroad across this isthmus to Don Jose de Garay; but, not having complied with the conditions of the charter, it is alleged to be forfeited, which the grantee substantially denies, for, having failed to dispose of it in England, it has been lately offered to American capitalists. I have recently seen it stated in Mexican newspapers that the British house of Manning, McIntosh & Co. lay claim to the same rights, but whether by direct grant from the Government, or by transfer from Mr. Garay, I have not been informed. The Mexican Government seemed anxious to repossess the right of way.

Mr. Moro's surveys were conducted on the combined use of the barometer, astronomic instruments, and the theodolite; and it is to be regretted that his triangulations, limited mainly to the Pacific slope, had not been carried over to the Atlantic. He appears, however, to have experienced great difficulty in his operations from the winds and long continued wet and misty weather, although the periodic rain had not fairly set in. He says:

"From the frequency and force of the northerly winds, it became impossible to use the artificial horizon, and consequently the reflecting instrument. Even Borda's circle was employed with much difficulty, on account of the continued heavy rain which fell on the mountain at the season of the year when the survey took place. Three successive attempts were made to determine the latitude of Santa Maria Chimalapa. The two first proved quite unsuccessful, having in one instance waited eight days to effect our purpose; and even on the third occasion five days elapsed before we could accomplish our object. At many other places we also waited in vain for favorable weather to make our observations."

He also says:

"Every attempt to determine the longitude of that place (San Mateo, on the Pacific) proved vain, and I could only ascertain its latitude."

In reference to the climate, he states that he has frequently seen the mercury in the thermometer at Tehauntepec stand at 92° Fahrenheit at 7 o'clock in the morning.

The mouth of the river Huasacoalcos, or Coatzacoalcos, is situated in 17° 8′ 30″ north latitude, and 94° 17′ longitude west from Greenwich. The position of the Boca Barra, and of the debouch of the Tehuantepec river on the Atlantic, were not determined, for reasons already given. The latitude of San Mateo, a small village on the coast, between the mouth of Tehuantepec and Boca Barra was ascertained to be 16° 12′ 47″ N. No observations were taken here for longitude, owing to the unpropitious state of the weather, and no attempt seems to have been made to deduce it from the triangulations connected with points previously established. The Commission appears to have labored under many disadvantages in the prosecution of the survey. The weather is frequently so unfavorable as to prevent the determination of certain important positions, and then at a critical moment the rudder of the sounding boat is broken, in consequence of which an error of seven feet, in sounding the bar of the river, creeps into the report.

The facts before stated in reference to the manner in which the examinations of the isthmus have been made, taken in connexion with the remarkable discrepancies between Orbegozo's* survey and Moro's, (both seeming to be equally entitled to credit,) and the admitted error of the latter in taking the soundings at the mouth of the Huasacoalcos, has a strong tendency to create a feeling of distrust of the results which he has published. His trigonometrical and astronomical observations, however, are exempt from that suspicion, and are no doubt valuable contributions to geographical knowlege, and his geological collection, arranged by the celebrated Del Rio, possess a high interest.

One most serious objection to any communication across this isthmus for great commercial purposes is to be found in the want of safe and capacious harbors at either terminus. At the mouth of the Huasacoalcos there is but twelve and a half feet water at low tide, and it is exposed to the full force of the northers which prevail from November till April. I have seen thirty ships stranded in a single norther in the month of March. It may be said that the bar may be removed and an artificial harbor constructed at the mouth of the river. There is probably no more difficult problem in the science of engineering than the execution of such works under the best of circumstances; but I am far from asserting that skill and *money* may not accomplish them. The mouth of the Huasacoalcos is peculiarly ill adapted to such improvements, which would scarcely be inferior in magnitude to the harbor of Cherbourg, and would assuredly require the munificence and resources of a Louis XIV. for their execution. The bar, created by the action of a certain natural law, would, if removed, be immediately re-formed by the same cause to which it owes its origin, unless that cause should be so modified as to direct else-

* It is proper to remark that Gen. Orbegozo thinks that some of his barometric results may not be precisely accurate, as he suspected that the mercury had imbibed atmospheric air; but that he endeavored afterwards ' to correct the inaccuracies by the subsequent observations made at Tehuantepec previous to and after the exclusion of the air from the tube by the ebullition of the quicksilver."

where the deposition of earthy matter ; and in the present case the question would be further complicated by the silting up of the artificial harbor, if one should be built. Supposing that such a harbor should be constructed, it would still be liable to the objection of the difficulty and danger of access, especially for sail vessels, in the season of northers.

From recent examination of the isthmus by Mr. Moro (the partial results of which were published in the National Intelligencer of the 7th January, 1850,) that gentleman has arrived at the conclusion that the bar at the mouth of the Huasacolcos river, was formed, not from deposits from the floods, but by a ledge of soft argillacious rock, which he thinks may be easily excavated to the required depth, thus removing one of the principal objections to it as a harbor.

The whole shore of Tehuantepec is subject to the visitation of terrific hurricanes, (which take their name from the isthmus,) sweeping with resistless fury along this inhospitable coast, where the tempest-tossed mariner seeks in vain for a harbor of refuge, even for the smallest class of sea-going vessels. For this there seems to be no remedy ; the genius of man cannot control the storms, and nature is constantly interposing new physical difficulties in the way of navigation. Humboldt says, " the sea is daily withdrawing from the coast of Tehuantepec ; the anchorage is yearly becoming worse ; and the sand brought down by the river Chimalapa augments both the height and extent of the bar."

He further says, in his political essay on the Kingdom of New Spain, " the coast of Nicaragua is almost inaccessible in the months of August, September, and October, on account of the terrible storms and rains ; in January and February on account of the furious northeast and east-northeast winds, called *papagayos*. This circumstanstance is extremely inconvenient for navigation. The port of Tehuantepec, on the Isthmus of *Guasacolco*, is not more favored by nature. It gives its name to the hurricanes which blow from the northwest, and which frighten vessels from landing at the small ports of Sabinas and Ventosa." These storms are said to extend from two hundred to three hundred leagues to sea, but that they are frequently local and limited to a small space. The existence of these storms has been denied by persons who speak from personal observation. Humboldt was never on any portion of the great American Isthmus, and his information in reference to Tehuantepec was derived from the archives of the Vice-Royalty of Mexico. How far this authority was reliable I cannot pretend to say.

The country bordering on the Huasacoalcos is said to be " by no means unhealthy."* The whole of the Tierra Caliente of Mexico has been considered to be so deadly from the ravages of the *vomito*, the worst type of yellow fever, that the inhabitants of the temperate regions will not venture into it for half the year, unless impelled by a stern necessity, and it must be regarded as a

* Gen. Orbegozo does not concur in this opinion.

miraculous interposition of Providence or of "our Lady of Guadalupe" if the valley of Huasacoalcos be exempt from its visitation. It may well be that few deaths occur there, for there is scarcely any population. The old sergeant of the "invicibles" boasted that he had "commanded Fort Rivage, on the coast, for the whole war, and that it had never been taken;" to which the one-legged corporal replied, "because it had never been attacked." It has been asserted that the *vomito prieto* was unknown in Mexico until after the conquest. If this be true, the Spaniards have entailed a greater curse on that beautiful and unfortunate country than has generally been supposed.

The low grounds on the Pacific are, as a general rule, more healthy than those on the Atlantic. Mr. Moro relates a singular fact for etiological inquiry connected with the climatic influence of a portion of the isthmus. He says:

"However strange this may appear, it is nevertheless certain, and the *Rancho de los Mudas*, (settlement of the dumb,) established a few years since near the lower part of the island of Tecumichapa, owes its designation to the fact that the individuals are all dumb who inhabit the three or four houses which form the settlement."

Several different translations have been given of the word "Tehuantepec." According to one authority it means a "hurricane;" another calls it the "Mount of Livons," and derives from it the title of the Marquis of "Monteleone," held by the direct descendant of Hernan Cortez. Mr. Moro reders it "Tiger-Mountain."

## 2D.—NICARAGUA.

The former Province, now independent State, of Nicaragua has long attracted the attention of the world for its fertile soil, salubrious climate, (with the exception of the coast of the Caribbean sea,) its large lakes and rivers, and commodious harbors, and, above all, by the idea (fast gaining ground) that *here, if any where*, we must look for a practicable solution of the problem which has for its results the connection, by a ship canal, of the Atlantic and Pacific Oceans. Nature appears to have lavished her blessings on this favored region with an unsparing hand, and all travellers speak with enthusiasm of its magnificent scenery, its agreeable temperature, and its rich and varied agricultural productions.*

In examining the map of the old kingdom of Guatemala, since the revolution called Central America, one must be struck with its large interior lakes, discharging their surplus waters, on the one hand, into the Atlantic Ocean, and separated, on the other, by a narrow ridge, from the South Sea. On looking further we find, contiguous to those lakes, the harbors of Nicoya, San Juan del Sur, and particularly of Realejo, the most magnificent, with the

* See Juarros, Alcedo, Galindo, Stephens, Thompson, Montgomery, and Page.

exception of Fonseca and Acapulco, on the whole Pacific coast, where a thousand ships may ride in safety. In viewing all these facts, the observer must be impressed with that evident design of Providence which, when properly interpreted, we recognise in all its works. Nature was never so untrue as to hold out so strong a promise, and then to interpose barriers to its realization that may not be overcome by the energy and genius of man. It is a law that we must labor to accomplish that which we desire, and assist nature in her operation, else we should not appreciate the blessings with which we are surrounded.

The havens* of which we have already spoken, the great Lake of Nicaragua and its outlet, the river San Juan, lie exclusively within the territory of the State of Nicaragua. I am aware that a half-naked savage, called in burlesque "George Frederick Augustus the First, King of the Mosquito Indians," claims jurisdiction over the lower portion of the San Juan, including the harbor at its mouth, and that this absurd pretension is recognized and supported by a great European Power. If it were not for the serious consequences that may flow from this assumption of royal dignity and authority, and the deep humiliation and disgrace which it is calculated to inflict on a nation which we all desire to respect, the whole affair would be simply ludicrous, and the world would enjoy a hearty laugh at the travestie of his Majesty, George Frederick Augustus the First, as it now does at the amusing masquerades of "Fustian the Great," Emperor of all Hayti! But I feel admonished that this is *too dark* a subject to be approached with unbecoming levity.

In the investigation of the projected canal through Nicaragua, (which has not now arrested my attention for the first time,) I have read every thing that I could find touching the history and geography of Guatemala, and have not been able to discover one single fact to lend even plausibility to the pretensions of the Mosquito King, (who, probably, never dreamed of any till the suggestion was made by others,) but, on the contrary, every thing to condemn it. It is not, however, my province to discuss this question, and I have adverted to it only so far as it concerns the matter under consideration. If the affair rested with his Mosquito majesty alone, it could no doubt be satisfactorily arranged on the basis of a barrel of whiskey, a looking glass, a few strings of beads, and a cocked hat; a rusty sabre and a long pair of iron spurs (which would complete the royal costume) might be thrown into the bargain.

Seriously, the idea cannot be entertained that civilized nations will quietly submit to the frustration of a grand enterprise by the absurdities of a savage chief, even if he be sustained by a great Power. This "dog-in-the-manger" principle will not be tolerated in the middle of the nineteenth century.

Much has been written at various times on the subject of a ship canal through Lake Nicaragua, but we seek in vain for informa-

* The harbor of Nicoya is in the State of Costa Rica.

tion to fully satisfy the professional engineer. The most absurd schemes have been suggested, and apparently irreconcilable discrepancies* exist between the few and partial surveys, pretending to scientific accuracy, which have been executed; and no two travellers agree as to the dimensions and character of the lakes, or of the length, depth, and capability of improvement of the river San Juan. In reference to the harbors of San Juan of the Atlantic, of Nicoya, San Juan del Sur, and Realejo, and of Fonseca† in Honduras, there can be no question, as they have been carefully surveyed by the Spanish and British Governments.

We are left, therefore, very much to grope our way in the dark, from which we can be relieved only by an extensive and minute survey executed for the special purpose of settling the question. There is, however, an occasional glimmering of light to be perceived, by the aid of which we may be able to arrive at a probable conclusion.

Nothing can be more unsafe than the opinions of travellers, unaccustomed to the use of instruments, in reference to heights and distances; and all engineers, who have been employed on extensive surveys, know how to estimate them at their true value. The popular notion of "a dead level" is often equivalent to a rise of more than one hundred feet in the mile, and a "gentle ascent" to some three or four degrees. Even a practiced engineer will distrust the evidences of his own sight unaccompanied by instrumental observations. The state of the atmosphere exerts a wonderful influence on apparent heights and distances, and the best judgment may be entirely at fault. This I noticed to be particularly the case in the elevated plains of Mexico. We would there often see an object—a house, a rock, or point of a mountain—to all appearance but a few miles off, and yet a ride of ten miles would seem to bring you no nearer to it than when it was first discovered. Mr. Guizot was induced, by the representations of the commercial house of Salomon, based on information, as they asserted, derived from an engineer, that a thorough cut of forty feet would unite the Pacific and Atlantic Oceans, through the Isthmus of Panama, to dispatch a scientific engineer to verify that astounding intelligence. So far from this being true, the lowest summit found by Mr. Garella turned out to be 390 feet above high tide, and that was not suitable for his purpose. This serves to show how little reliance can be placed on *popular statements*, even when backed by the alleged authority of an engineer.

Before proceeding to the consideration of the several proposed lines, it may be well to establish certain principles which must govern, and which are applicable to them all.

The canal must be of such dimensions as to accommodate the largest class of ships engaged in the Pacific and Indian trade. It must be provided with adequate harbors at its terminii. There must be no unnecessary detention in the transit. The summit level

* It will be seen that we have endeavored to explain these differences.

† The Gulf of Fonseca washes the conterminous boundaries of San Salvador, Honduras, and Nicaragua.

must not be higher than Lake Nicaragua, or, at the furthest, Lake Leon; for from those great natural reservoirs we must derive the supply of water. It can be procured from no other sources. It will probably require one or two harbors on the lake to protect it from the storms. It ought to be constructed on the cheapest and *shortest* practicable route.

A canal of the size of the "Caledonia" might answer a good purpose, but I doubt if it would be large enough. It is 20 feet deep, 50 feet wide at bottom, and 122 at the top. The locks are 20 feet deep, 172 feet long, and 40 feet wide. I should prefer a canal of dimensions approaching to but rather exceeding those of the grand ship canal of Holland,* (which I examined with much care in the year 1841, and described in a report printed by order of the Senate.) It commences opposite to Amsterdam and terminates at Nieudiep, near the Helder, and was constructed for the purpose of avoiding the difficult navigation of the Zuyder Zee, in which it has been completely successful. Its breadth at the surface of the water is 124½ feet, the breadth at the bottom 36 feet, and the depth 20 feet 9 inches. These dimensions are well adapted to steam navigation, a consideration which ought not to be disregarded. It might be well to increase the width at water line to 126 feet, the bottom width to 40 feet, and the depth to 21 feet. As the bottom cutting will probably be through rock, the slopes may be somewhat less than ordinary; the locks should be 47 feet wide and 210 feet long between the gates.

Three routes have been proposed by which to connect Lake Nicaragua with the Pacific: 1st, from the foot of the lake to the Bay of Nicoya; 2d, from the town of Nicaragua to San Juan del Sur, on the Gulf of Papagayo; 3rd, from the upper end of Lake Leon to the port of Realejo. All these plans contemplate either a canal along the Rio San Juan from the Lake to the Atlantic, the improvement of its natural bed, or a combination of both.

We are indebted to our distinguished American traveller, Mr. Stephens, for much valuable information concerning the country surrounding Lakes Leon and Nicaragua, derived from his personal explorations, and from the surveys executed by Lieutenant Bailey, (a retired British navy officer,) under the orders of the Government of Central America. Mr. Stephens is not only a close and acute observer, but he possesses also the happy faculty of imparting knowledge in the most agreeable form. Mr. Bailey thus describes Lake Nicaragua:

"The Lake of Grenada is ninety geographical miles long, its greatest breadth is forty, and the mean twenty miles; the depth of water is variable, being in some places close to the shore, and in others half a mile from it, two fathoms, increasing gradually to eight, ten, twelve, and fifteen fathoms, the bottom usually mud. This basin is the receptacle of the waters from a tract of country six to ten leagues in breadth on one side of it, thrown in

*The absolute cross section of the Caledonia canal is somewhat greater than that of the Grand Canal of Holland, but its capacity (owing to the arrangement of the dimensions) is rather less.

by numerous streams and rivers, none of them navigable except the River Frio, having its source far away in the mountains of Costa Rica, which discharges into the lake a large quantity of water near the spot where the River San Juan flows out of it. The embochure is two hundred yards wide, and nearly two fathoms deep. There are several islands and groups of islets in different parts of the lake, but none of them embarass the navigation, nor is this any where incommoded by shoals or banks, other than the shallow water in shore ; and even this is but very trifling, or rather it is no impediment at all to the craft at present in use, the practice being to keep the shore close aboard, for the purpose of choosing convenient stopping places at the close of day. as they scarcely ever continue their voyage during the night.

The largest islands on the Lake are Omotepe, Madera, and Zapetera. Taken together the first two of these islands are twelve miles long. Zapatora is almost triangular, and five miles long. Sanate, Salentinane, and Zapote are smaller, and uninhabited ; but some of them, and the last in particular, are capable of cultivation.

" Near the town of Grenada there is the best anchorage for ships of the largest dimensions.

" The Lake of Nicaragua," says Mr. Bailey, " is connected with that of Leon by means of the River Pinaloya, or Tipitapa,) navigable for the boats employed in that country for twelve miles, as far as the place called Pasquiel, where the inhabitants go to cut and bring away Brazilian timber. The four miles which remain between that place and the Lake of Leon, are not navigable for any kind of boat, whatever may be its construction, because beyond Pasquiel the channel is obstructed by a vein of rocks, which when the river is swollen are covered with water, but in the dry season the water sinks so low that it can only escape through gradually diminishing fissures in the rocks. At a distance of a mile beyond this first vein of rocks, we find another more solid, which, crossing the river at right angles, forms a cascade of thirteen feet descent.

" The river Tipitapa,* which discharges into the Lake of Nicaragua, is the only outlet for the Lake Leon."

Lake Leon (or Managua, as it is often called,) is about thirty-five miles long, and sixteen miles at its greatest width. It is the receptacle of a large basin of drainage, but the streams flowing into it are small in size. According to some authorities it is more shallow than Nicaragua, while others describe it as being deeper. This is an important fact to be ascertained. Its banks are higher and more perpendicular than those of the latter, and its level might be raised if necessary by the erection of a dam at its outlet.

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* " According to Mr. Stephens," says M. Michael Chevalier, " the whole fall of the river Tipitapa, which amounts to twenty-eight feet, is comprised within the first six miles from the Lake Leon. Mr. Rouhaud, who has assisted in the topographical discoveries in that country, has told me that the fall of twenty-eight feet was distributed as follows, viz : Eighteen feet are precipitated by a cascade at Tipitapa, and the remaining ten feet and a half descend from Tipitapa to Nicaragua."

Mr. Shepperd,* an American skipper, who resides at Blewfields, and has traded on the Lakes of Nicaragua and Leon, qualifies Mr. Bailey's description of the former by saying that it has fifteen fathoms of water *in some places only,* and that at its outlet it has only seven feet of water, the shoal extending a long way into the lake. This is another point requiring investigation.

As a proper understanding of the San Juan river is necessary to our subject, I do not know that I can do better than to transcribe Mr. Bailey's account of it (although it has been often published) as our most reliable authority. But, before doing so, it may be well to remark that Captain Sheppard, already referred to, differs somewhat from Mr. Bailey's conclusions. That gentleman, for the prosecution of his business, built a vessel of fifty-two tons burden for the navigation of Lake Nicaragua. At the end of a rainy season he commenced to ascend the river, and it required twenty-two days' hard labor, (eighteen of which were occupied in warping,) to reach the lake. He says that there is a ledge of rocks across the channel, about half-way up the river, where, in the summer, it is necessary to unload the *bongas*, haul them over the ledge, and reload them before they can reach the lake. An attempt was made in the early part of the present year to ascend the river with a small steamer; but the experiment, I believe, was unsuccessful. It is asserted, by other persons, that the ledge of rock to which Captain Shepperd alludes is a dam erected by the Spaniards "in the olden time," to prevent the ingress of the buccaniers† to the lake from the Atlantic.

"The river San Juan," says Mr. Bailey, "flows from the Lake of Nicaragua at its southeastern extremity, at the place where formerly stood the Fort of St. Charles, now completely destroyed. Here is the only discharge for the waters of both the lakes. The whole length of the river, pursuing all its windings from St. Charles down to the port of San Juan del Norte, is ninety miles, (others say one hundred and four miles,) it forms a magnificent stream, somewhat irregular in its breadth, which varies from one hundred to two hundred yards, studded with small islands, forming for the most part a channel on each side of them. The depth of water varies from one and a half to seven, eight, and nine fathoms. In the midstream, the depth is generally from three to five fathoms; but during the rainy season, namely, from May to November, the depth is considerably increased, for, according to observations made at the ruined fort near Grenada, in calm weather, in October, 1838, when the rainy season had just terminated, and again in May, 1839, before the rains had commenced, when the lake was at the lowest, the difference of height between these extremes, was found to be six feet six inches. In

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* See Liot on intermarine communication.

† The pirates often attacked the Spanish towns on Lakes Nicaragua and Leon. In April, 1680, Capt. John Davis, an English buccanier, with eighty men, ascended the river and lake to the town of Nicaragua (in three days from the Atlantic) and sacked it of money, plate and jewels, worth 50,000 pieces of eight. The infamous Lalonois made a similar attempt afterwards, but was defeated with great slaughter, few of his band of miscreants having escaped.

November, 1839, at which time the rains had ceased, the same observations were made, and the result was that the waters had risen fourteen inches less than in the previous year.

"The banks of the river, particularly the right, are fringed with wood of all sizes and descriptions, with a dense undergrowth, forming altogether a forest nearly impenetrable; consequently there are no inhabitants, nor is the land cultivated, although of prodigious fertility. The immediate shores are undulating, being in some parts not more than a few feet, and in others between twenty and thirty feet above the surface of the water.

"Two large rivers, the San Carlos and Sarapiqui, besides many small streams, discharge into the San Juan.

"From the gentle declivity, of the river San Juan the current is not strong, being at the rate of a mile or a mile and a half per hour, except in the time of freshets, when it is accelerated variously, according to circumstances. It is navigated all the year round by boats of eight or ten tons burden, called bongos, and which are generally manned by ten or twelve men, besides the patron. They can carry about one hundred ceroons of indigo, or five hundred hides, or a proportionate quantity of Brazilian timber. The obstacles which now prevent the advantageous navigation of the river San Juan, are first, the rapids; second, the drainage occasioned by its efflux into another river, called the Colorado, seventeen miles above the port of San Juan; and lastly, the labarinths of small islands, which extend ten or twelve miles from the opening of the river Colorado to the mouth of the river San Juan. It is generally believed that at some former epoch the Spaniards purposely enlarged the opening of this branch, with the intent of exhausting the main river at that part to such an extent as to render the river impracticable to navigation, hoping thereby to protect the town of Grenada from external attacks. In the present stage of the science of civil engineering, this obstacle would be easily surmounted. The rapids are four in number, called Del Toro, Del Castillo Viejo, De las Blas, and de Machuca, all comprised within an extent of ten miles, but there is a clear waterway from one to the other, having good depth of from three to six fathoms; the longest of these rapids is not more than one mile. The rocks by which they are occasioned, are all placed transversely to the current, leaving a narrow channel on each side, and showing their ragged and sharpened edges above the surface of the water during the dry season.

"The breadth of the river from this point is between one hundred and one hundred and twenty yards; the current rushes with violence, and dashes with great force against and between the projecting points. The bongos, however, make the passage without hazard, and we have never heard of the occurrence of an accident.

"The Colorado diverges from the San Juan in 10° 50′ north latitude, and, after running in a southwesterly direction, falls into the sea in 10° 46′, forming a dangerous bar. This river abstracts

from the main stream a considerable quantity of water, the opening from the San Juan being twelve hundred feet wide, and having in the deepest part nine feet of water at the lowest state of the river. From measurements of this section, carefully taken at two different periods, in May when at the minimum, and in July when much increased by freshets, it appears from calculation that at the first period the loss of water from the river was 2,817,885,840 cubic yards. The main current being thus suddenly weakened, the motion of the water becomes sluggish, and the natural effect is, that deposites of sand and mud are formed, which gradually augment where the movement of the water is feeble; trunks of trees and other floating bodies grounding on these, small islets are formed by successive aggregations, which soon become covered with rank grass, reeds, and other herbaceous plants of rapid growth: a great number of these mounds have been thus raised, and the progress of formation is continually going on. The usual methods of clearing the beds of rivers could here be applied with facility and good effect, as the accumulations are nothing more than silt and sand, with occasional logs buried underneath. A dam across the Colorado branch, constructed on such of the well known plans as might be judged the most efficient, would be indispensable. Then the re-forced body of water, aided, if necessary, by the resources of art, would, by the momentum of its increased velocity, soon clear a channel to the depth that should be deemed requisite; other parts of the river, where such operations might be wanted, could be improved by nearly similar methods, as the bottom is every where composed of mud and sand, except about the rapids, where it is of rock or loose stones."

I think it may well be questioned whether the river is suited, owing to its great floods and large masses of floating timber, for a slack-water navigation for large ships, with the exception perhaps of that portion of it below its off-shoot, the Colorado, which might be closed. This, however, is of little consequence, as the valley affords a most favorable trace for a canal, which would be considerably shorter probably than the river itself, and cheaper than a system of canalization. All this is very plain work. The difficulty of the undertaking lies elsewhere. Knowing the elevation of the lake, its abundant supply of water, and the amount of lockage to be overcome, it matters little how wide or deep the San Juan may be, in different places and at different times, or how many shoals, reefs, rapids, or ripples may be found in its bed, or how much water it may discharge in the dry season. The lower reaches of the canal may be fed either by means of dams erected across the river or from its affluents; but the main supply, after all, must come from the lake, that inexhaustible natural reservoir. It is possible that the upper portion of the river, as far as the first rapids, might be used for ship navigation, and that the whole length of the independent canal need not exceed sixty miles.

It has been suggested that a route for a ship canal might be found by following the course of the Carlos river, a tributary to the San Juan, and thence across to the Rio Grande, which, heading far up towards the Lake of Nicaragua, discharges into the Gulf of Nicoya. Another route has been proposed by the river Serapiqui, a considerable affluent of the San Juan, and the river Aranguez, flowing into the above named gulf; but there is not much probability of finding a gorge in the ridge of partition sufficiently low to be supplied with water; and, if there were, there is a strong, if not insuperable objection to the harbor on that gulf. Mr. Stephens says "all the ports of Central America on the Pacific are unhealthy, but this was considered deadly." Col. Don Juan Galindo* gives the following topographical description of this region of country, from which we may infer the impracticability of all the projected routes through the State of *Costar-Rica*,† and, in fact, also through the neighboring province of Veragua:

"The southwestern slope is easily accessible, gradually inclining, nearly thoughout its whole extent, from the genial temper which favors vegetation and relieves man in his daily labors, to the insupporable heat and aridity which announces languor and sterility. On the northeastern side, on the contrary, the aspect is more rugged, and nature appears as if she wished to display her power by placing at every step difficulties, wonders, wrecks, and ruins. Every thing here is great—the number, complication, and height of the mountains; the large rivers, and even the small ones, excite the fear and attract the attention of the traveller, who considers their capacious channels, which they fill in winter, carrying along with them immense rocks by their impetuous current, as also the largest trees, broken and scattered here and there, and borne away with masses of earth torn by the waters from their lofty shores; inaccessible heights, deep abysses, beautiful and delicious plains, every thing is found full of fertility and abundance, from the most elevated peak to the shores of the ocean."

After this quotation it is scarcely necessary to say that there is not much probability of finding a favorable line from the foot of of the lake through the high volcanic range of Miravoga to the Gulf of Nicoya. It would be time and money misspent to make the examination; for it is not likely that even a feasible railroad route would be discovered in this region.

The next route in order is from the town of Nicaragua, on the Great Lake, to the port of San Juan del Sur. This is the shortest distance (so far as we are informed) between the waters of the Caribbean and South seas. From the waters of Las Lahas, discharging into the lake, to the source of the San Juan of the Pacific is only one league;‡ but those streams fall rapidly from the

*This scientific officer and accomplished gentleman was barbarously murdered in 1840 by Carrera's party, after the battle of Taguzegalpa. Had his life been spared, we might have expected from him highly valuable papers on the geography and resources of Ceutral America, which he was preparing at the time of his melancholy death.

† This is Galindo's orthography.

‡ To this naked fact but little importance can be attached.

dividing ridge. Two surveys have been made across this strip of land; the one by Lieut. Bailey, the other by Don Manuel Galisteo, under the direction of the Captain-General of Guatemala, in the year 1781. The former makes the level of the lake 128 feet 3.05 inches above the Pacific. The height of the dividing ridge above the Pacific $615\frac{67}{100}\frac{3}{0}$ feet, and consequently $478\frac{300}{1000}$ above the lake. This latter height, with the addition of the depth of the canal, (21 feet,) gives the altitude to overcome, say in round numbers, 508 feet; the distance is $15\frac{2}{3}$ miles. Galisteo's results are different in many respects, and by far more favorable. He makes the elevation of the lake 134 feet above the Pacific, and of the dividing ridge 289 feet above that plane, and of the dividing ridge above the lake 155 feet. To this add the depth of canal, (21 feet,) and we have 176 feet of elevation to surmount.

He makes the distance between the lake and the port of San Juan del Sur a little over 17 English miles. The results of these surveys differ in one respect most essentially. In the elevation of the lake the disagreement is only six feet, which may be accounted for on the supposition that the tides in the Pacific were not at the same level when the two surveys were commenced, and that the lake was not at the same stage. This difference, at any rate, is not sufficient to discredit either. But Bailey reports the dividing ridge to be 487.600 feet above the lake, while Galisteo states it to be only 155 feet, showing a difference of 332.600 feet. Mr. Galisteo makes the distance nearly two miles longer than Mr. Bailey. The fair inference, I think, is that they passed over two separate and distinct summits, and that it is not necessary to suppose that either was seriously, if at all, in error. It would be well, however, if these surveys were verified. Mr. Bailey proposes to lock up from the lake some 70 feet, and then to tunnel through the ridge, but we can find no evidence that this summit could be supplied with water. Lake Leon, which is only 28 feet 8 inches higher than Lake Nicaragua, obviously would not answer the purpose. There is not even fall enough to bring its waters to the debouch of the proposed canal on Lake Nicaragua. This project, then, so far as our information extends, is *impracticable.* On the supposition that Galisteo's survey is correct, the objection in regard to water disappears, for we have the large lake for our reservoir, and that of course is ample. The sole physical difficulty then to be encountered is the dividing ridge of 155 feet elevation, (falling rapidly on both sides,) 21 feet, (the depth of the canal,) or a total of 176 feet. This is no doubt a formidabe obstacle, but is it sufficient to prevent the execution of this great and noble enterprise? I should hope not.

The Hon. Charles Fenton Mercer, in his report as chairman of the Committee on Roads and Canals to the House of Representatives, (March 22, 1839,) after carefully reviewing Mr. Galisteo's survey, remarks:

"All the difficulties, therefore, attending the construction of a continuous canal from the Lake to the Pacific occur in the eight

miles next to the lake; for about six miles of which the elevation of the earth exceeds the surface of the lake more than 60 feet, and for two miles of the six it averages about 135 feet, and for about one-third of a mile it reaches 150 feet, but never exceeds that height."

If this route should be adopted it would involve the necessity of an open *thorough* cut (for a long tunnel on a ship canal would be highly objectionable, and in the present case more expensive) at its greatest depth of 176 feet, with a lockage down to the Pacific of about 134 feet. In point of real difficulty this work would be less formidable than the celebrated *Desague* of Huehuetoca, which was dug for the purpose of preventing further inundations of the valley of Mexico, (and of the capital,) which had been frequently submerged, sometimes for years. This great drain is over twelve miles long. For more than two miles this cut varies from 98 to 131 feet, and for half a mile, through the hill of Nochistongo, it is from 147 to 196 feet deep, or twenty feet deeper than it would be necessary to cut on this line for a ship canal of the largest dimensions ever executed. The breadth of the *Desague* is at bottom 13 feet, and at top (over the deepest cut) 360 feet.

From the want of information as to the nature of the formation to be penetrated, it would be impossible to assign the dimension of the cut and of the quantity of the excavation. Of course, under these circumstances, all estimates of cost must be conjectural; but we hazard little in saying that it might be executed for a sum not exceeding $10,000,000 or $12,000,000.

The next line proposed is by the way of the river Tipitapa (also called Panaloya and Managua) and Lake Leon,* and thence across the country to the Port of Realejo, on the Pacific. The best publication on this subject is a small volume written by Prince Louis Napoleon Bonaparte, (President of the French Republic,) whilst a close prisoner in the fortress of Ham, and is highly creditable to his industry, ingenuity, and powers of investigation and analysis. The most important portion of it has been re-printed with Mr. Rockwell's recent report. Mr. Michel Chevalier has also published an able and interesting memoir on the subject of intermarine communication between the oceans.

The fall of the river Tipitapa (which is the outlet of Lake Leon) is 28 feet 8 inches, and its length is 17 miles. It is supposed that the first twelve miles from Lake Nicaragua might be rendered navigable for ships, leaving five miles of independent canal. The better plan would be to canal the whole distance. Whether Lake Leon is deep enough for ship navigation is a matter of uncertainty; some persons asserting that it is deeper, and others more shallow than Lake Nicaragua.

Dampier, who visited this region in the year 1680, on a military expedition, says, that "to arrive from Realejo to Leon, we must

* Frequently called Lake Managua.

go twenty miles across a country flat and covered with mangles." He also says that, from the lower end of Lake Nicaragua to the port of *La Caldera*, on the Gulf of Nocoya, is about 30 miles, and that the intermediate country "is a *little hilly*, but for the greater part level and like a savanna." This, however, does not agree with Colonel Galindo's account, who was probably of the two the more accurate observer. The "*little hills*" I suspect will turn out to be high mountains.

After ascending from the western extremity of Lake Leon a few miles, the ground falls very gently, according to Mr. Stephens, the whole distance to the Pacific. Mr. Richaud speaks of the country in the same terms. He estimates the height of the ridge of partition at 22 feet above the surface of the lake. "Then comes a small zone, on a very slight and yet sensible declivity, by which we gently descend to the Pacific ocean." Other information places the highest ground at forty-nine and a half feet above Lake Leon. A Mr. A. G***, who, according to Mr. Bonaparte, explored the country in 1842, and carefully investigated its formation, says:

"The western coast of the Lake of Leon is twenty-six feet above the Lake. From hence the land rises gradually for a distance of 2,725 yards to an elevation of fifty-five feet six inches. Here is, then, the culminating point, whence the ground gently descends to the ocean."

We ought to infer from the precision of this information that it is the result of actual survey.

This certainly shows a wonderful unanimity of opinion amongst those who have visited the country, and ought to dispel all doubts as to the entire practicability of this route for a ship canal. Nay, more; if this information be correct, it establishes the extreme feasibility of the work, when compared with the vast consequences which may flow from its execution.

Captain Sir Edward Belcher, R. N., explored a portion of this country in 1838, in his voyage round the world. He was informed that the *Estero Real*, a river rising near Lake Leon, and flowing into the Bay of Fonseca, in San Salvador, was navigable for sixty miles above its mouth for vessels drawing ten feet water. He ascended the river for about thirty miles, and found it to agree with the description of the natives. He expresses the opinion that it is fed very near the Lake of Managua, and thinks that the ground between its head and the lake is low and narrow. Capt. Belcher says:

"It has been suggested to carry a railroad from Leon to the Lake of Managua, (Leon.) As to any canal into the Pacific, unless behind Momotombo, Felica, and Viego range, into the *Estero Real, I see little feasibility in the scheme.*"

If the maps which I have consulted be tolerably correct, there would be just as little feasibility in the route which he suggests. The Estero Real does not head nearer to the lake than thirty

miles; and if we may judge of it by the maps, and of what is said of the rivers Realejo and Tosta, rising in the same ridge, its sources must be greatly elevated above the lake. If it be navigable for vessels drawing ten feet water for sixty miles, we may estimate its whole length at not less than eighty miles. If to that we add thirty miles to the lake, we have 110 miles of ship canal, with a high summit to overcome, and a probable deficiency of water, for we must, in that event, abandon the lake as a reservoir.

The harbor of Realejo has two entrances, both of which are described by Captain Belcher as safe *in all weather*. The least water on the one bar, according to the chart, is 24 feet, and on the other 30 feet. Inside the Island of Cardon, which acts as a natural breakwater, the depth varies from 6 to 7, 8 and 9 fathoms in the harbor. The extreme rise of tide is 11 feet. "Docks or slips, therefore, may be easily constructed, and timber is readily to be procured of any dimensions; wood, water, and the immediate necessaries and luxuries are plentiful and cheap."

By the Lake Leon and Realejo route the distances and lockage may be stated as follows:

Canal, or canal and slack-water navigation—

| | *Distance.* | *Lockage.* |
|---|---|---|
| In the San Juan - - - | 100 miles. | 134 ft. in. |
| Lake Nicaragua - - | 100 " | |
| River Tipitapa, - - | 17 " | 28 " 8 |
| Lake Leon, - - - | 35 " | |
| To Realejo, - - - | 29 " | 162 " 8 |
| Total, - - - - | 281 | 325 4 |

The height of lockage is stated on the supposition that the two oceans are on the same level at medium tide. I do not clearly understand whether or not Mr. Bonaparte contemplated a summit level higher than Lake Leon. If the ridge of partition be no higher than has been estimated, to raise the summit level would be unnecessary and objectionable for many reasons. It will be seen by the above that the canal or combination of canal and slack-water navigation will be about 146 miles. Mr. Bonaparte thinks that there will be only 82 miles to be worked. I suppose he means of independent canal.

By the Nicaragua and San Juan del Sur route, the distances and lockage will stand nearly as follows:

Canal or canal and slack-water navigation—

| | *Distance.* | *Lockage.* |
|---|---|---|
| On the San Juan - - - | 100 miles. | 194 feet. |
| Lake Nicaragua - - | 60 " | |
| To San Juan on the Pacific | 17 " | 134 66 |
| Total - - - - | 177 | 268 |

Of this distance 117 miles would be canal, or a combination of canal and river navigation. This route is, then, shorter than the

other by 104 miles, and its summit level would be 28 feet 8 inches lower; but, on the other hand, the cut would be 100 feet deeper, and the harbor of San Juan del Sur is in every respect inferior to that of Realejo, and in the season of popagayos it is difficult of access, although that objection may be obviated, in a great measure, by the use of steam.

I think that we have *reasonable* grounds for *belief* that both these routes are practicable, with summit levels, in the one case not higher than Lake Nicaragua, and in the other than Lake Leon, at a cost not exceeding $20,000,000; but it is very difficult to estimate, even approximately, the expense from our present data, which are quite insufficient for the purpose.

You ask if a survey should not be made of these routes. I answer most assuredly, *yes*. But it ought to be extensive, careful, and minute. It ought to cover the whole basin of Lake Nicaragua (of course including Lake Leon and the San Juan river) and the country separating it from the Pacific. Every line which may possibly give a favorable result should be examined, and the ground should be bored in many places, and sufficiently deep to ascertain the character of the formation beyond a doubt. And precise locations and working plans should be furnished for every probable route,* in order that fair comparisons may be instituted between them. There ought also to be made accurate charts of the lakes. The survey of the Isthmus of Panama, executed under my directions, cost nearly $50,000, and yet every possible economy was observed. A considerable portion of this was expended on salaries of engineers, much of which, if it had been conducted by the Government exclusively with its own officers, might have been saved. A survey such as I have indicated above would cost about $75,000, but the sum of $50,000 might produce satisfactory practical results. A less sum would answer no other purpose than to ascertain the mere practicability of the scheme. And yet what are these sums compared with the gigantic work the practicability and cost of which they may determine; "a work," says Southey, "more important in its consequences than any which has yet been effected by human power."

[Since the above was written I have seen a map and profile transmitted from Nicaragua, purporting to be from actual survey, from which I deduce the following results:

| | | |
|---|---|---|
| Length of River San Juan - - - | 90 | miles. |
| " Part of Lake Nicaragua traversed by the line - - - - | 110 | " |
| " River Tipitapa - - - | 18 | " |
| " Lake Managua - - - | 55 | " |
| Distance from thence to Realejo - - | 40 | " |
| Total length | 303 | miles. |

* This would of course include the route from near the village of Tortugas, on Lake Nicaragua, to Salinas Bay, an excellent harbor. Culebra and Thomas' Bay are also excellent harbors.

*Elevations.*

| | | | |
|---|---|---|---|
| Height of Lake Nicaragua above Atlantic | 147 feet | | |
| " Same above Pacific - - | 128 " | 6 in. | |
| Height of Lake Managua above Atlantic | 176 " | 5 in. | |
| " Same above Pacific - - | 156 " | 11 in. | |
| Summit above Lake Managua | 55 " | 1 in. | |
| Summit above Atlantic - | 231 " | | |
| Summit above Pacific - | 212 " | | |

Showing a difference of 19 feet between the level of the two oceans. The elevation of Lake Nicaragua is probably estimated from its outlet.]

### 3D.—FROM THE BAY, OR RATHER LAGOON OF CHIRIQUI, TO THE GULF OF DULCE.

According to Galindo, these waters are separated by a high range called the Cabecaras Montaños, and we have no information that there is any considerable depression in them to recommend this route for favorable consideration. About 30 miles east is the Boca del Toro, on the Atlantic, said to be an excellent port. A canal route has been suggested from this place following up the Escuada River, (the boundary between Central America and New Grenada,) and thence to Chiriqui, (or Cherokee, as it is frequently called,) on the Pacific, where there is also a good harbor, which was surveyed by a British frigate the last winter. This route is represented by some persons as being favorable, but from the mountains indicated by Galindo, this is not probable. In truth, we have very little information in relation to it. It has been said that excellent coal is found on this line. Last winter I sent one of my party to examine the coal, and to bring me numerous specimens of it, which he did; they turned out to be bituminous clay, shale, and a very impure and extremely *sulphurous lignite*, unfit for any purpose. It is, I think, very improbable, judging from what we know of the geology of the isthmus, that a true coal will ever be discovered on it. It by no means follows that every collection of vegetable matter should, when covered by sedimentary sand and clay, be converted into coal. It depends on the presence of other substances, and the change of wood into coal may be produced by a process somewhat similar to that of petrefaction, (as it is popularly called,) by which fossil trees are impregnated by silex, or carbonate lime; and the formation of coal may depend on the water, to which the wood is exposed, being charged with bituminous matter.*

### 4TH.—ISTHMUS OF PANAMA.

The Isthmus of Panama is now better known than almost any portion of Spanish America, or indeed, we might say, than of many

*See report of Evan Hopkins, C. E., F. G. S., on the Geology of the Isthmus of Panama.

of the States of our Union. It has been completely covered with a net of triangles—the elevations of the dividing chain of hills, and of the most important isolated mountains, have been determined by the barometer. Lines of levels have been run in different directions between the oceans; the topography of the isthmus has been delineated, and the streams and rivers guaged; the character of the geological formation, and much of its natural history in other departments, investigated; and there is scarcely a ravine in a width of more than forty miles, measured along the crest of the central chain, that has not been explored. Here we cannot complain of want of information; and, as I personally conducted the recent surveys across the isthmus in reference to the construction of a railroad, I can speak of it with much confidence, and shall therefore treat the subject with more detail than I have bestowed on the consideration of the other routes.

In the month of January last I accepted the appointment of chief engineer* of the Panama railroad from Messrs. Aspinwall, Chauncey, and Stephens, of the city of New York, who had secured the right of way, with liberal concessions, from the Government of New Grenada; and immediately organized a large corps of engineers, which was dispatched in the same month, with written instructions, to the scene of operations.

The written instructions were based on such information as we were able to collect from the labors of others in the same field. I particularly refer to Major Lloyd, to Mr. Garella, and to the surveys executed under the immediate eye of Mr. Stephens, (one of the association,) by Mr. Baldwin, and Mr. Tracy, American engineers, in the year 1848. The first survey was made under the auspices of President Bolivar, for the purpose of solving the problem of the level of the two oceans; the second under the orders of the French Government, to ascertain the practicability of a ship canal, and the last mainly in reference to the determination of the height of the summit-ridge. I shall have occasion to refer hereafter more particularly to these different explorations.

It may be proper here to remark that the British Pacific Steam-Packet Company had also caused examinations to be made of the isthmus by Mr. McGeachy, Crown Surveyor of the Island of Jamaica, and by Mr. Evan Hopkins, a geologist and mining engineer; but their results were not known to us until the completion of our operations.

Within the limits of our explorations, the principal streams flowing into the Pacific are the Rio Grande, debouching near Panama, and the Caimeto, discharging into the Bay of Chorrera, at Vaca del Monte, about twelve miles to the southwest of Panama. These rivers have numerous tributaries, all bearing the same characteristics, and form in fact two great basins of drainage, separated by high lateral ridges, for all practical purposes impassable; so that, whichever valley is selected,

* On the completion of the report (in July last) on the survey and location of the road, I resigned the appointment of chief engineer, and since that time have had no connection with the the company.

it is essential to confine the location to that valley. The water-courses fall rapidly near their sources, shedding the downfall water with great velocity to their lowest levels, where, of course, the streams rise in the rainy season suddenly to great heights. At a short distance from the dividing ridge they assume the appearance of wide, deep valleys; sometimes exhibiting vertical rock escarpments, and become, under ordinary circumstances, very sluggish in their currents. This is probably owing more to the geological formation of the country than to the erosive action of the waters. It will be at once perceived that, and I wish to have it borne in mind, for the better understanding of what is to follow, that this peculiarity renders it almost impossible, at least not advisable, to pursue what is technically called "a valley location," especially where we would have had to encounter so many tributaries near their mouths, at which places they are all invariably wide and deep. We were therefore compelled to keep above the main streams, and to cross the secondaries as near their sources as possible, and thus crossing the subordinate dividing ridges intervening between the tributaries.

This was more particularly the case between the Rio Chagre and the Pacific, although, measurably, the same remarks apply to the Chagre valley itself.

On the Atlantic slope, the Rio Chagre, a large and important river, opens far up towards the Pacific, and furnishes a short and easy means of transit to that ocean.* It rises in the Boqueran mountains, a high range, transversal to the main dividing ridge, and domineering above it to the east of Porto Bello.

The Rio Chagre runs in a curvelinear sweep from its source to its mouth. For the first half of its length it flows in a south-westerly direction, nearly parallel to the dividing ridge, to the mouth of the Obispo, (one of its important affluents,) and then, suddenly changing its course to a few degrees west of north, follows it to the ocean. It is a very crooked stream, frequently and abruptly changing its course.

It is a large and noble river, about one hundred miles long, and from Cruces down varies from two hundred to three hundred feet in width. Its banks are high until within a few miles of the village of Chagre, and never overflows, except at a few points, in seasons of extraordinary floods.

By the removal of the snags from the channel, and the improvement of some of the bars between Dos Hermanos and Gorgona, light draught steamers may ascend, *at all times*, to within a few miles of the latter town, and, for ten months in the year, may without difficulty reach that place. The sum of five thousand dollars would, in my opinion, be ample to effect that desirable object.†

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* It may be proper to remark, that the Chagre river, swelled as it is by large and numerous affluents, and draining an extensive region, rises rapidly after the sudden and heavy tropical rains. It is often seen rolling down in waves from three to four feet high. It frequently rises ten feet in an hour, and, when the rains cease, falls as rapidly. In the dry season it receives no more water from its tributaries than is exhausted by evaporation.

† In the rainy season, the portage for light canoes by the Chagre and Rio Grande valleys is not more than five miles. A boat of nearly 800 lbs. weight was last summer carried from Gorgona to Panama, via the Pedro Miguel and Rio Grande. This is undoubtedly the shortest portage between the two oceans, except at Nicaragua.

Its most important tributaries are the Obispo, Quebrada, Agua Salud, Trinidad, and Gatun. The Obispo rises in the dividing ridge, and follows an easterly course, nearly parallel with it, until it is joined by the Mandingo, when, by a slight deflection, it falls into the Chagre river, between Cruces and Gorgona. The Quebrada and Trinidad, both large rivers, have their origin high up in the same range, towards Chorrera, and flows in a northeasterly direction. The Gatun rises in the vicinity of Porto Bello, and flows in a northwesterly course, nearly parallel with the Atlantic coast.

The Atlantic slope is (as an inspection of the maps will show) within our limits, divided into four basins of drainage, subordinate to the great basin of the river Chagre. This basin in confined on the west by a mountain range, in the neighborhood of Chorrera, called the Sierra de Chame, which is higher than the dividing ridge, and completely intersects it from ocean to ocean. A corresponding range limits it to the east of Porto Bello.

The subordinate basins are separated by ridges, often higher than the dividing ridge. It will therefore be seen that we were necessarily confined to such valleys as we in the first place selected, it being impracticable to pass from the one to the other. These basins are formed by the drainage of the Cruces, Obispo, Quebrada, and Trinidad rivers.

The forces to which the formation is due appear to have acted, principally, in two different directions. The one uplifting the main connecting link of the two continents, and the other elevating the transversal ridges, as we have already shown. From these axes other diverging or radiating ridges have been thrown out for short distances in the direction of the lines of least resistance. The valley of the Chagre can scarcely be regarded strictly as one of denudation. It is probable that when this country was upheaved, there was no well defined outlet between the summit and the Atlantic, but that the secondary ranges were connected with low narrow rides, in consequence of which a series of lakes were formed by the first rains, at different levels, falling successively towards the ocean. The accumulation of the water at last broke through these slight barriers, and, in the natural course of things, reduced the outlet to a nearly uniform plane, the highest of these lakes, at a distance of forty-four miles from the ocean, having been but fifty feet above it. The valley of the Chagre has evidently been formed, *not* by the deposition of earthly substances from the river, but from the decomposition of the rocky hills, (subsequently mixed with vegetable matter,) and a long series of abrasion from the downfall water. The river, which is extremely crooked in its course, winds around the terminations of the hills, from side to side, presenting in every respect a striking contrast to the Mississippi, the Arkansas, Red river, and other southern rivers, which have formed their alluvial valleys, by deposites from their muddy waters. This comparison will probably illustrate my meaning. With these brief remarks, which I con-

sidered essential to a proper understanding of what is to follow, I shall now dismiss this portion of the subject.

It was, of course, apparent from the commencement that our line of road must necessarily occupy some part of the Chagre valley; but which of the subordinate four basins, and which bank of the river we should select, was a matter for grave consideration: depending, in fact, mainly upon the most eligible line leading from the Pacific to the summit of the dividing ridge.

As has been before stated, there are two basins of drainage on the Pacific slope, viz: the Rio Grande and the Caimeto. In making the selection we derived much advantage from Garella's survey. That gentleman, in the year 1843, carefully triangulated nearly the entire belt of country to which our operations were confined; sketched in the topography, from his different points of triangulation, so as to form a pretty exact and connected *ensemble map*, exhibiting the contour of the country, the mountain ranges, detached hills, ravines, and course of streams, with considerable minuteness. He also determined the height, at various positions, of the central chain and isolated cerros by means of the barometer, and carried a line of level and survey from the port of Vaca del Monté to the Atlantic, following the valley of the Caimeto for several miles, and then that of the the Bernardina (a large affluent to the former) to the Ahogayaquan Pass, where he proposed a tunnel of nearly three and a half miles long; after which his line descends the Boneta and the Quebrada to the left bank of the Chagre river. This survey, of course, saved us much labor, as we should otherwise have been compelled to go over much of the same work. Still, it was neither sufficiently minute nor extensive to serve as a basis for a railroad project. And the summit level which we finally adopted seems to have entirely escaped his observation, as he shows no pass less than a hundred feet higher than ours. Mr. Baldwin's survey, in 1848, established the important fact that a pass of 337 feet above the Pacific existed, and we were induced to believe that a still lower one could be found.

Upon a full consideration of the whole subject, it was deemed expedient to select for our location the valley of the Rio Grande, for the following brief reasons: The natural harbor of Panama is the best on that coast, and offers infinitely greater facilities for the construction of a commodious harbor than the bay of Vaca del Monté, at the mouth of the Caimeto. It presented the shortest and most direct line, as traced on the map, to Limon Bay, which had been previously chosen as the Atlantic terminus. It promised the lowest depression in the central chain, and a crossing of the Chagre river, at its narrowest width, and with high banks, instead of crossing it at Gratun, where its bed is wide and banks comparatively low, avoiding altogether Quebrada and Trinidad rivers.

Besides these advantages, we were induced to hope that, from the nature of the country, we should be able to make a better disposition of the gradients, than on the more western, or Chorrera line. A section from the mouth of the Chagre to Vaca del

Monté has been described as "presenting a very gradual ascent, as far as the marshy land, near the Cordillera of Trinidad, then a rapid ascent of 450 feet, followed by a corresponding fall to the Pacific."

A further examination of the country fully sustained those expectations, and also resulted in the discovery of a pass through the central chain of only 275 feet above the Pacific; *the lowest depression between the oceans*, so far as has been ascertained by actual survey.

A description of the minute topography of the country in the vicinity of our line of location would be foreign to the objects of this paper; and it will therefore be sufficient to say, briefly, that beginning at a point on that part of Limon bay called Manzanilla harbor, about six miles east of the town of Chagre, the line pursues a southerly direction, until it reaches, without serious impediments, the valley of the river Chagre, which it follows to within a mile of the town of Gorgona, (on the left bank of that river,) where it crosses the river at an elevation of more than forty feet above its bed, (with a bridge of 210 feet opening,) and then, still in the drainage of the valley, but leaving its banks, it crosses the country towards the summit of the dividing ridge, which it reaches in a distance of about ten miles: from thence it immediately descends to the drainage of the Rio Grande, and following the general direction of its valley terminates on the shores of the Pacific, in the vicinity of Panama, about ten miles from the central chain. All the serious obstacles to the construction of a railroad occur within a limit of ten miles, in the vicinity of the summit, and they are less formidable than those which have been successfully overcome on many roads in the United States. The gradients are favorable. Between the Atlantic coast and Gorgona, they do not exceed twenty feet to the mile, and the dividing ridge *may be* surmounted by comparatively short grades of 45 feet to the mile, involving a summit cut of 2,000 feet long, averaging 35 feet deep, mostly of hard rock. The Company has, however, as a temporary arrangement, and in reference to their present limited resources, adopted higher gradients in passing the summit than those proposed in my report. The necessity for the modification is greatly to be regretted, as the efficiency of the road, as a great commercial work will be, in consequence, much depreciated. As it regards the transportation of passengers, baggage, bullion, and light packages, it is not a matter of so much consequence. The excavation will generally be in red clay or trap-rock; occasionally alluvial sand or rock less difficult than trap may be met with; but this will be the exception, not the rule.

The entire length of the line of road, when the whole shall have been carefully revised, will not exceed but probably fall short of forty-six miles. The total amount in miles, surveyed to obtain that line, was three hundred and thirty-six and a half miles, exclusive of the reconnoissances made by myself and the chiefs of division, which were numerous and extensive.

The contracts for the execution of that portion of this great work, lying between Gorgona, (the head of navigation on the Chagre river) and Panama, have been concluded with a company of gentlemen every way competent for its execution. They have just finished the construction of a large canal connecting two branches of the Magdalena river, in New Grenada, with *native labor*. This fact removes one of the great difficulties which was anticipated in the prosecution of public works within the tropics; and as the contractors, from their long familiarity with that country, and knowledge of its climate and resources, must be supposed to fully understand the nature of their undertaking, we have a right to infer that this important work is on the eve of its accomplishment; thus erecting another monument to American skill and enterprise. It is but just to the New Grenadian Government to say that it has thus far acted in good faith towards the railroad company, and has exhibited a liberal and enlightened policy in its concessions, which shows a high appreciation of the advantages to be derived from the opening of this new communication, not only by its own citizens, but by the civilized world. In the extensive grant of land which they have secured to the company, they have also conceded the royalty of the mines, which may be covered by it, thus suspending for, I believe, the first time in the history of Spanish America, the "laws of the Indies" in reference to mining operations; and as the indications are strong of the existence of the precious metals, this may prove of great value to the company or to the colonists who may purchase these lands.

As regards the termini of the road, the *precise* points have not yet, for obvious reasons, been selected, though it is known that Limon bay, on the Atlantic coast, and the bay of Panama, on the Pacific, present opportunities for such selection which will secure all that is desirable for those purposes. The former is six miles east of Chagre, surrounded by high land, and is represented as being as healthy as any place on the Atlantic side of the isthmus. It is very capacious, with deep water and good anchorage, safe even now, and capable of adaptation to all business purposes by inexpensive works. No breakwater is necessary to its safety as a harbor, and it is sufficiently commodious for all the purposes of commerce, for a century to come, without resorting to artificial constructions, except in the building of wharves to facilitate trade. Good and abundant water may be obtained in the vicinity of the bay, and I am not aware of the want of any points of excellence which recommend our best harbors.

The harbor* formed by the island of Manzanilla, in Limon Bay, has been examined by Lieutenants David B. Porter and Cadwallader Ringgold, of the United States Navy, who have reported most decidedly in its favor; and Captain Tucker, of the steamer Orus, who was in the constant habit of frequenting it during the

*For very accurate charts of Limon Bay (including Manzanilla harbor) and of the Bay of Panama, we are indebted to the British Admiralty

last winter, pronounces it safe in the worst storms without artificial protection; and this opinion is confirmed by an old Colombian navy officer, who has long been familiar with this coast. Some misapprehension has existed on this subject from the fact that Mr. Garella recommended an expensive breakwater at the terminus of his projected canal. The apparent contradiction is, however, easily reconciled. The canal, from the nature of the ground, must necessarily terminate on the *open bay*, exposed to the northwest, the direction of the prevailing winds, while the railroad terminates behind Manzanilla island and Point Coco Solo, stretching out from the mainland, which afford ample natural protection against the storms.

On the Pacific the character of the Bay of Panama is well understood. Partaking in an eminent degree of the nature of the ocean, so well named *Pacific*, storms rarely occur to ruffle its placid waters, and tempests are unknown. The beautiful islands in this lovely bay afford great facilities for commerce. Toboga particularly possesses an abundant supply of pure and delicious water, falling in cascades near the shore, from which the largest vessels may be watered in a few hours when the necessary fixtures are erected. It is true that the waters of the bay, near the shore of the main land, are not sufficiently deep to allow vessels to lay alongside, and until proper works are built the business must be done as heretofore by means of lighters; but a minute examination has been made of the harbor with reference to its improvement and connexion with the railroad, and the conclusion I have come to is that, by a judicious system of works, involving no contingency as to their practicability and success, a harbor may be made at the very terminus of the road of ample magnitude, depth, and safety, offering advantages not inferior to any on the whole Pacific coast.*

When this improvement is effected vessels may be rapidly discharged at the immediate terminus of the road. It is true that to secure this object the outlay will be large, but the terms of the charter are so liberal, and thegreat amount of business so certain, as to put the question of profit on the investment beyond a contingency.

On the question of *health*,† I consider that the adverse accounts have been much exaggerated. Such of the inhabitants as live here in the *manner of civilized beings* enjoy as good health as the people of the North, and of the great number of emigrants who have passed over during the present season but few have suffered from local diseases. Now, considering the exposure to which they have been subjected, the loose habits of many of them, their long *detention* on the *isthmus*, and their constant excitement, it is a proof of salubrity that so few have suffered. At present such is the mode of life of the native, from Chagre to Panama, that there is scarcely a tenement fit to give protection to a weary or sick

*All that can be said adverse to the harbor of Panama is, that it is, under present circumstances, inconvenient. But even now it is in every respect a better harbor than Valparaiso, San Francisco, and many others on the Pacific coast.

†It must be borne in mind, however, that our personal observations were limited to the months of *February*, *March*, *April*, *May*, and the early part of *June*, which are amongst the healthiest months of the year. See Dr. Halsted's report, appendix B.

traveller, and I believe that, with what *we* consider the ordinary means of protection against the consequences of exposure and good medical attendance, health may be preserved very thoroughly. A small expenditure, in the erection of houses or shanties, for the employees and operatives (which should be provided with floors and divided into apartments) would secure health and produce economical results.

The most exaggerated ideas have been entertained respecting the health of the isthmus, which, with the exception of the town of Chagre and Porto Bello, (owing to local causes,) is probably as salubrious as most countries of the same elevation within the tropics. Mr. Moro, the engineer of the Tehuantepec route, says it was so sickly that Major Lloyd and Capt. Falmarck could not complete their survey, and that Lloyd died soon afterwards in consequence of his exposures. The survey *was* finished, and Major Lloyd has since filled important official places in the East Indies, and was certainly *alive* a few months ago. It has also been asserted that animals lose the power of propagation in consequence of the enervating effects of the climate. If these travellers would visit Chagre and Porto Bello they would see most conclusive evidence to the contrary, at least as far as the human species are concerned. I have known one man, a native of Porto Bello, to count more than thirty living children of whom he claimed the paternity, and the parish priest was supposed to exceed him in the number of his progeny. Humboldt, adopting the representations of others, says that it is unfavorable to the growth and multiplication of cattle, and recommends the cultivation of exotic grasses. This is a great mistake. Wherever I found settlements, I was struck with the beauty and number of the cattle, and with the exception of the savannas on the Pacific, the pasturage of sweet and natural grasses,* even in the driest season, was most luxuriant and abundant. Our surveying party, exposed to all the vicissitudes of the climate, suffered but little, until near the close of the survey when a good deal of sickness appeared, owing to the fact of the men being several days exposed to the rains without being able to change their clothes, and we lost but one person out of eighty employees, whose melancholy death was occasioned by inflammation of the bowels, induced by great imprudence in eating improper and indigestible food. The *vomito* is here unknown. The prevailing diseases are of an intermittent character.

According to Major Lloyd and Captain Barnett, the flag staff at the Castle of San Lorenzo, at the mouth of the Chagre is in

Longitude 79° 59′ 33″ west (of Greenwich.)
Latitude 9° 19′ 39″ north.

Major Emory, of the Corps of Topographical Engineers, makes the longitude of Chagre, (not the castle,) by chronometers, 80° 01′ 21″ west of Greenwich.

Major Emory, after a long series of exact observations at Panama, makes the northwest bastion of the fortifications as follows, viz:

* Particularly the *grammaloti*.

| | |
|---|---|
| Latitude | 8° 57′ 12″ 15‴ north. |
| Longitude | 79° 29′ 24″ 4‴ west of Greenwich. |
| Magnetic declination | 6° 54′ 37″ east. |
| Magnetic dip | 32° 00′ 00″ |

Intensity 0.87507, (uncorrected for difference of temperature.)

The intensity at Falmouth, England, having been taken as the unit.

According to Captain Sir Edward Belcher, of H. M. ship Sulphur, the northeast bastion at Panama is in

Latitude 8° 56′ 56″ north.

Longitude 79° 31′ 12″ west of Greenwich.

Major Emory says: "From March 22d to May 12th the maximum temperature was 89° Fahrenheit, which occurred April 25th. The minimum during the same period was 69° 5″ Fahrenheit, occurring March 27th and April 5th, 1849. The mean temperature during the same period was nearly 80° Fahrenheit." Major Emory has kindly permitted me to use his results, and I refer, for a better understanding of them, to his letter of 10th of May last.

The extreme rise of tide at Panama is twenty-two English feet, a fact very favorable for the construction of docks. At Limon Bay it rises twenty-four inches. I have not attempted to investigate the interesting philosophical question of the difference of levels of the two oceans, because we had not the time to expend upon it, having been compelled to use our best efforts to accomplish the more practical matters which had been entrusted to us. Our levels from Gorgona* to the Atlantic have not been tested, and, although we have no reason whatever to distrust them, I do not feel myself at liberty to make them a basis of speculation to determine so important a problem. For minute information on this subject I refer to the published reports of Major Lloyd and Mr. Garella.

I have not attempted, nor do I consider it necessary in this paper, to draw any comparison between the route across the Isthmus of Panama, and other projected lines intended to accomplish the same object of an intermediate communication between the Atlantic and Pacific oceans. It may not be out of place, however, to remark that this line is the shortest by far from sea to sea; that it now has the shortest portage, with the exception of Nicaragua and the Raspadura ravine, and the lowest known pass over the continent between the arctic circle and the Strait of Magellan, and may be constructed for the least expense. In view of harbors it possesses a most decided advantage, and in regard to health is inferior to none. Besides this, its geographical position, in reference to the trade of India, China, Australia, and the South Pacific coast, commend it especially to the attention of the commercial world. Even now, in spite of the vexations, detentions, and expense which attend it, it is the only route of communication with our Pacific territories which presents any attraction. It is the most economical, certain, and healthy route.

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*Between Gorgona and Panama the levels were repeatedly checked, and found to be exact, which lends great confidence to those taken below Gorgona, although they were not proved.

As regards the vast importance of the road, and the influence it is calculated to exert on the great interests of commerce, I refer to the report of the Hon. T. Butler King (from the Committee on Commerce) to the House of Representatives at its last session, and to an able and philosophical communication from Lieut. Maury, of the navy, printed with the report of the Hon. J. A. Rockwell, (from a select committee of the House of Representatives,) recently published.

In reference to the construction of a ship canal on this route, I should think the question of its practicability more than problematical, unless all consideration of cost be disregarded. This opinion I ought to express with great diffidence, since Mr. Garella has arrived at an opposite conclusion, after a careful and laborious investigation of the question. But, as our recent lines of survey completely covered the country to which he looks for his principal supply of water, I feel compelled to say that I consider it altogether inadequate for the purpose, and that the feeders indicated on his maps (and which were probably not traced by an actual survey) are impracticable except at an immense expense.

Besides this, the cost of the work is undoubtedly placed much too low. Mr. Garella estimates the whole expense of the canal, including the artificial harbors at Vaca del Monté and Limon Bay, at 139,000,000 of francs, or about twenty-seven millions of dollars. He proposes a tunnel through the summit chain 122 feet high, 69 feet wide, and 5,900 yards long, with open cuttings at its termini of 160 feet deep. He supposes, and I have no doubt correctly, that his whole tunnel must be pierced through solid porphyry, and yet he estimates this at 12 francs ($2.28) the cubic metre, whereas three times that price would probably not accomplish it. We shall be compelled, therefore, to largely increase Mr. Garella's estimate; and when we look to the probable deficiency of water for the summit level suggested by him, and the consequent necessity of assuming one still lower, it will not be very extravagant to place it at a cost of $50,000,000.

I do not wish to be understood as asserting that Mr. Garella's project is absolutely impracticable; but that, if he had actually traced his reservoirs and feeders with instruments, he would have found physical difficulties of a character which he did not suppose to exist, and which we shrunk from encountering with our railroad, which might far more easily have been accommodated to the nature of the ground. Mr. Garella would have been compelled to project long tunnels and vast aqueducts, of dimensions never before contemplated for feeding canals; hence it is I have said that he would probably have to adopt a still lower summit level than the one suggested. I am far, however, from questioning that gentleman's science or skill, for his survey and report exhibit both, and it was evidently the want of time that prevented him from more thoroughly investigating the subordinate but highly important branches of the subject. I do not doubt that he could collect all the water for which he estimates, but it would certainly be at an immense cost.

There is one other point in which I think he is mistaken. It is a very natural one. He thinks that the tunnel, passing as it would through solid rock, would not require *arching*, except possibly for an inconsiderable extent. But when we look to its great size, and weight of the superincumbent mass resting on its vertex, it would be unsafe to trust to its natural strength.

The Penaenabach tunnel (comparatively small) is the only one in England, that I am aware of, that is self-supporting. It is driven through solid basaltic rock. The Penmaenwahr tunnel, pierced through hard greenstone, had to be lined throughout; and the Bangor tunnel, which was at first supposed to be sufficiently firm, has been recently cased with brick. Mr. Garella calculates the additional cost of arching at 13,900,000 francs, making a total of 139,000,000. For an open cut forty-five feet higher than the tunnel he estimates the cost at 149,000,000 francs, and for an open cut on the same level 165,000,000. The higher level would, of course, be still more objectionable, not only on account of the additional lockage, but also of the increased difficulty in supplying it with water.

The line which I have traced for a railroad is, I think, more favorable for a ship canal than that suggested by Garella.* If we were to adopt the same depth of cutting which he recommends for an open cut, it would leave the bottom of the canal on our line, only forty-four 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 195 feet deep—the precise maximum depth of the celebrated Mexican desague of Huehuetoca—would obviate all difficulty in the crossing of the Chagre river at Gorgona, while the Rio Grande, the Obispo, and the Mandingo might be converted into immense reservoirs for supplying the summit level with water, and the Rio Chagre from above Cruces, and the Pedro Miguel, Cameron, &c. would furnish the lower levels. This work would be enormously expensive, and I am far from recommending it to public attention. A spacious tide-basin might be constructed for ships in the mouth of the Rio Grande, a few miles to the west of Panama.

The principal towns of the Isthmus Province† are Panama, Porto Bello, Chorrera, Los Santos, Nata, Darien, and the small villages of Chagre, Gatun, Gorgona, and Cruces, on the Rio Chagré. The population is supposed to be about 100,000, but the census is taken with so little care that it is difficult to arrive at any satisfactory result as to the number of the people. A large proportion of the inhabitants are of Indian, negro, or of mixed blood, in various proportions of white, black, and copper-color. Mulattoes in easy circumstances, and most of those in which the white feature predominates, are, by courtesy, classed with the "Sangre Azul" or "Gentes de razon," terms applied to white people. The

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* Owing to the close proximity of this line to the "source of supply," the summit level might be considerably more elevated.

† The provinces of Veragua, Panama, and Darien, formerly constituted what the Spaniards called the "Tierra Firma" or the *Spanish Main* of the Buccaneers.

inhabitants of Chagre, Gorgona, Cruces, and of the rancherias on the river, are nearly all of the unadulterated African race, or "Zamboes," a mixture of Indians and negroes, liberated slaves from New Grenada, or from the West India Islands. Large numbers of them, also, are to be found in the city of Panama, and in Porto Bello. They are physically strong and muscular, but in character most degraded, ignorant, and besotted. Capable of great toil and endurance, and submitting, when necessary, most cheerfully to abstinence, they are lazy, treacherous, drunken, and gluttonous, (when they can procure the means of indulgence,) and are, on the whole, the worst population I have ever known, entertaining no other idea of *liberty* than *freedom* from work and the *license* of being as impudent as they please to the whites, who stand in no little awe of them.

The ordinary life of the *cargadores*, or porters, while I was on the isthmus was something like this: A fellow would wait at Gorgona for a job, which he would not undertake without enormous wages. He would then carry a trunk to Panama, and immediately return; but so long as a penny was left, no earthly power could induce him to engage on any other work. During this short interval, his principal indulgence was to gorge himself with food, to get drunk, and to sing and dance all night, making in the meantime as loud and hideous a noise as possible. This usually lasted some three or four days, at the end of which period, *if he escaped dying of cholera*, he was ready for another expedition, to be succeeded by another round of bestial dissipation.

The rural population, consisting of Indians, and a mixture of Indians and whites, called "Mestizos," is of a different character. They are simple, frank, honest, and hospitable, but indolent, owing, perhaps, to the want of inducement amongst them to labor, and to the fact that the spontaneous products of the soil, with yams, a little rice, corn, and beef, supply all their frugal wants; and nowhere, probably, on the earth's surface, does nature reward more bountifully a little industry, judiciously applied. But for this, it would be "a marvel and a mystery" how the inhabitants, limited as they are, find subsistence; for, with the exception of the savannas on the Pacific, and an occasional patch of sugar cane, maize, or rice, (on the sides of the highest hills,) the portion of the isthmus which I visited is one unbroken primeval forest, and one sees every where around him the greatest, most magnificent, and beautiful developments of vegetable life, gratifying at once the senses of sight and smell. It is like one vast *greenhouse*, abundantly watered with limpid mountain streams, of which the celebrated conservatory at "Chatsworth" is but a feeble imitation. The growth is so extremely dense as to be almost impenetrable without cutting. The trees, of which there are a great variety, grow to an immense size—from fifteen to twenty-five feet in diameter, and towering to the height of a hundred feet, some of them eighty or ninety feet without a limb, and one species throwing out, some twenty feet from the ground, four large

*flying buttresses*, (for I know not how else to describe them,) the planes of which intersect at right angles. These contrivances of nature to sustain the enormous tree against the violence of the winds, are singularly like the light flying buttress one sees in European Gothic cathedrals. More than forty kinds of trees, valuable for ornamental and useful purposes, are known to exist on the isthmus, the most of which, although of rapid growth, are hard and lasting; some of them are liable to injury from the attacks of white ants, which soon destroy them; others, again, are exempt from their ravages, and are very durable under water, not only resisting decay, but the inroads of the *testudo navalis*. The most important of these trees are the alfagilla, bungo, cedro, or cedar, (out of which large coasting canoes, sixty feet long and six feet wide at the gunwale, rigged with sails, are made from a single tree,) cedro cebollo, caobo, or mahogony, another and fine-grained mahogony called caobilla, coco bolo, ebony, garapata, guachapali, a kind of teak, lignum vitæ, quira, (very hard and compact, used for rollers in sugar mills, and very difficult to work,) nispero, and zapodilla, the two last resembling each other closely, and being probably identical. All of these timbers are admirably adapted for building purposes, and some of them are known to have been in use for at least two hundred years in exposed situations, and are still perfectly sound. As to their strength and durability, there can be no question. For a more particular description of the timbers of the isthmus, I refer to the extracts from a report by Wm. H. Sidell, Esq., principal engineer of the Panama Division, appended to this letter.

Besides the before-mentioned timbers, the Indian Rubber tree and the cow-tree, or arbol de vaca, are quite common, and a vine which supplies, when cut, a cup of cool and delicious water, to which we often resorted, to slake our thirst.

There appears to be two kinds of the cow-tree—the one called by Humboldt Palo de Vaca, the other described by Dr. Webster, surgeon of H. M. sloop Chanticleer, as the "Vacco-dendron Lactifera," or milk-bearing tree. It is this latter species, I think, which is found on the isthmus, although Humboldt's tree may also exist there. Dr. Webster, in speaking of its juice, which is collected by tapping the trunk of the tree, says: "It seems rather startling to talk of a tree yielding milk; but such is the fact, and it is drunk by the people in large quantities, and was used by us at the gun room table, for mixing with tea, in lieu of cow's milk, from which it is no ways distinguishable in general use. The milk is a rich, white, bland fluid, without odor, and of the taste and flavor of common milk. It mixes readily with tea or coffee, without curdling or undergoing any change, and in every respect seems like cow's milk. Boiling water does not alter it. It keeps unaltered six or seven days in the temperature of 85°. In fourteen days it evolved a sour odor, but had not coagulated; a gummy pellicle adhered to the cork. Some vinegar was added to the recent milk without producing any immediate change; in forty-eight hours it acquired an unpleasant odor."

He further states that the timber of this tree is valuable for ship-building.

Humboldt says, "It is at the rising of the sun this vegetable fountain is most abundant; the blacks and natives are then seen hastening from all quarters, with large bowls to receive the milk, which grows yellow and thickens at the surface." Capt. Charles Cochrane, of the Royal Navy, in his work of travels in Columbia, speaks of two different cow trees. One he calls the *Liria*, which corresponds with Dr. Webster's description; the other *Sandi-tree*, which he thinks is Humboldt's. The milk of the latter, he says, " is not so agreeable as that of the Liria," on which the negroes of Escondie, on the Pacific, who drink it in large quantities, grow fat.

The Liria is a very lofty tree, rising frequently to the height of more than one hundred feet, the bark of a brownish color, and the leaf large and ovate. It flowers in February, or early in March, and produces a nice fruit, said to resemble in flavor " strawberries and cream ;" I did not taste it.

Amongst the numerous natural fruits of the isthmus may be enumerated those of the achras caimito, the liria, already mentioned, the guava, the peach mango, the lime, and the aguacaté, or alligator pear, which grows on the Lauras Persea. This last is a very valuable and pleasant fruit, constituting an important part of the food of the people. It is altogether unlike any other fruits that I have seen. It makes a delicious dish with sugar, or with pepper and salt; or a first rate salad when properly dressed; or it may be eaten as butter, and is sometimes called " subaltern butter ;" or as a vegetable with cold meat. It is said to be, when boiled, a true vegetable marrow. Its seeds answer a good purpose for marking or indelible ink. The orange, the lemon, and the pine apple are found growing wild in the woods, but are probably not indigenous. We must not omit to mention here the rose-apple, (*euginia jambos*,) a delicious fruit.

Coffee and cocoa are cultivated to some extent; the first for domestic use, and the last for exportation. The vanilla is indigenous, rarely cultivated, and does not constitute an article of commerce; but might, no doubt, be grown to advantage. Wheat, it is said, has yielded well in the few experiments which have been tried to test its adaptability to the soil and climate. One of the greatest blessings to the people of this region is the cocoa-nut tree, which affords them food, drink, coarse cloth, and various domestic utensils. It is a most beautiful object and always forms, with the stately and waving palm, a graceful feature in tropical landscapes. Not inferior in importance to the cocoa-nut are the plantain and banana; which, together with the *casavé*, are meat and bread to the natives.

The different vines of the country, of which there are a great variety and immense numbers, when twisted, are excellent substitutes for cordage; and a plant called *peta*, somewhat similar to the Mexican *sortal*, yields an excellent and fine soft thread, from which linen may be fabricated. Its leaves are large and

the fibres long, strong, clean and resembles flax, and may be easily separated, when first gathered, from the leaf.

The isthmus has been celebrated for venomous snakes, scorpions, and other poisonous reptiles, but our surveying parties met with few of that description. Only two large serpents were seen, supposed to be anacondas, one of them within three miles of Panama, and the other near Navy Bay. If we may judge from our own experience, snakes, scorpions, centipedes, and tarantulas, are rare; and mosquitoes are not abundant, at least in the dry season.

But there are other insects whose sole purpose of existence would seem to be the annoyance of the unwary traveller. Amongst them may be enumerated *garapatos*, a blood-thirsty kind of ticks, which are extremely numerous, the *pulga*, or savannaflea, the common flea, and the *niquas* or *chijos*, which fasten upon the tender parts of the feet, especially about the toe joints, and soon cause a very inconvenient, painful, and sometimes dangerous sore, if not extracted in time. The natives are very adroit in removing them, as their skill is called into daily requisition,

The wild animals are tigers, oucelots, two different kinds of wild hogs, bears, raccoons, deer, many varieties of monkies (the young of which the natives eat) including the champanze, and a curious beast called, according to Major Lloyd, "the *macho* or *vacca del monté*, and also *danta*, nearly of the size and appearance of a jackass, which, when shot, is considered a great dainty." It gives name to the harbor at the mouth of the Rio Caimito (or Alligator) river, in the vicinity of which it is frequently found and hunted. The natives say that lions are sometimes seen.

The birds of the isthmus are less numerous, and their plumage, with few exceptions, less brilliant than I had supposed. They consist mainly of wild turkeys, pheasants, (or birds resembling them,) ducks, pigeons, parrots, parroquets, macows, and an infinite variety of humming birds. The zopilotes or turkey buzzards are seen everywhere, actively discharging their natural and useful duties of scavengers. A crowd of them is usually attended, or rather apparently directed, by one or more king vultures, or *caciques*, as they are called, who are uniformly treated by their subjects with profound respect. It is quite amusing to see the king vulture gorging himself on the dainty parts of a dead mule or alligator, while a hungry crowd of zopilotes are observing him with the deferential air of the obsequious courtiers of the grande monarque, when his Majesty graciously permitted them to see him eat his royal dinner at Versailles. At other times the sovereign of the vulture tribe seems to be holding a council, surrounded by his *black guards*, or perhaps commanding some one of his trusty servants to watch the last agonies of a dying horse. The *guana* or *iguana* is esteemed by the inhabitants as a great delicacy, and it is said that foreigners, after they have overcome the disgust excited by its appearance, also become fond of it; and certainly, so far as physical beauty is concerned I do not know that it is much inferior to its culinary rival the terrapin, so popular on the shores

of the Chesapeake. He must have been truly a brave man who first ventured upon eating either. The guana is a large, hideous, green lizard, crested on the back and throat, with an inflated gular pouch. Its body is about two feet long, and tail three feet long. It is a very formidable and dangerous looking animal, but perfectly harmless, and as timid as a hare. It possesses extraordinary tenacity of life, and Dr. Webster says that the inhabitants of Para, who are very fond of its eggs, "open the abdomen and cut the oviducts, with the chain of eggs, and let the animal go again in the hope of catching him again next year, for nature repairs the injury." "I was surprised to find that each egg contained a fœtus or embryo guana; the heart of it was beating strongly. In all the females of this species that I could obtain, the eggs were uniformly the same, and contained a live young one. It is therefore ovoviviparous."

The capital and most important city of the Isthmus Province is Panama. It contains about ten thousand inhabitants, and is remarkably healthy. (See Dr. Halstead's report in the Appendix.) It is an ancient and walled town, most pleasantly situated on a tongue of land projecting into the Pacific ocean, which washes its walls on three sides, and whose light breezes agreeably temper the tropical heats. Formerly it was a place of great consequence and wealth, but its principal public edifices are fast falling into ruins. The private houses are large, airy, and commodious, and well adapted to the climate, but the town is not well watered, its chief supply being brought on mules from a stream some three miles distant. The view seaward from the ramparts is most lovely. The magnificent Bay of Panama lies before it, studded with beautiful volcanic islands, covered with cultivated gardens to their highest peaks, or green with the graceful vegetation of the tropics, while on its bosom float the largest class of merchant ships and majestic steamers freighted with the riches of *El Dorado;* and, as if to add animation to the magic scene, hundreds of canoes, with their white lateen sails, skim its placid waters "like things of life," flitting to and from the shore, from island to island, and from ship to ship. At a distance they might be taken for those great ocean birds whose ancient haunts they have disturbed.

The present city of Panama must not be confounded, as it has recently been, with old Panama, about four miles to the southeast, which was destroyed by the buccaniers in 1670. It was built on the site of an Indian village, situated on a low, marshy plain, and was considered to be very unhealthy. This, together with its exposure to the attacks of pirates, caused it to be abandoned, and the new town to be founded in its present position. It would seem almost unnecessary to add that it was commenced long after the death of Hernan Cortez. It was from the old town that Pizzaro, Almegro, and their adventurous associates sailed for the conquest of Peru.

The great drawback to the otherwise agreeable city of Panama is its *excessive filth.* It is probably one of the dirtiest towns in the

world, garbage and offal of every description being thrown into the streets; and its salubrity, under such circumstances, is the best possible commentary on the climate. Its only scavengers are buzzards, swine, and fowls, and the periodical rains perhaps remove a portion of the rubbish, otherwise it would be utterly intolerable. It reminds one forcibly of Coleridge's celebrated apostrophe to the "town of Cologne," commencing:

"Ye nymphs who reign o'er sewers and sinks."

Next in consequence is the town of Porto Bello. It was discovered by Columbus in 1502, who appropriately named it the *beautiful harbor*. It is situated in latitude 9° 34′ 35″ north longitude, 70° 45′ west of Greenwich. It is nearly surrounded by high mountains, which, shutting out the sea breeze, render the heat oppressive; and, in connection with exhalations and decomposition of vegetable matter, the climate extremely unhealthy.

Porto Bello was formerly celebrated as the depot for the rich trade of the South American Pacific coast, but her glory has departed, and she is now nothing more than a miserable negro village of about 1,200 inhabitants. Dr. Webster, in speaking of it, says: "This town was once indeed the treasury of the Old and New World; bars of silver and ingots of gold were piled in the streets, without fear or anxiety for their safety. On these occasions the most gorgeous display of specie was to be seen at Porto Bello; revelry and feasting were kept up; the presence of ships laden with merchandise, the vast influx of traders, contributed to enliven the scene; and at this time the rent of a floor in some of the houses cost the prodigious sum of $1,000 per month. But this was in the "good old times" of Porto Bello—her golden age, that is not likely to return, nor any incitement to renew the system of buccaneering."

Formerly a paved mule road existed from Panama to Porto Bello via San Juan on the Pequini, but it is now dilapidated and unused. In consequence of representations which had been made of a feasible railroad route leading from Panama to Porto Bello, I caused the intermediate country to be carefully examined, but the result was extremely unfavorable.

Of the villages it is scarcely necessary to make further observations, than that they are generally composed of small, uncomfortable reed houses, some of which are left open, and others are plastered with a mixture of clay and cow dung, the latter material exhaling at all times, especially in the rainy season, a not very agreeable but, it is said, healthy odor. Some of these tenements are thatched with palm leaves, and others covered with earthern tiles, but all are without floors.

The condition of the people is greatly inferior to that of Mexico, and a marked difference exists in their apparent devotion to and respect for religion and its ministers, if we may judge from the universal dilapidation of the churches on the isthmus. In Mexico, on the contrary, every little village has its small but neat church in a decent state of repair.

The limits of this paper necessarily restrain me from presenting many detailed facts which might nevertheless have an important bearing on the question, and I have therefore, notwithstanding the great accumulation of matter in my possession, treated it in a general way, giving results, rather than the elements from which they have been obtained; and have touched but slightly upon the meteorology, health, natural productions and resources of the isthmus, on which a volume might be written. But I propose at some future time, and in a different way, to attempt to do ample justice to this interesting subject.

[It is proper to remark, in closing this portion of the subject, that the examinations in the vicinity of Limon Bay were not as minute as could have been desired, or as will be necessary before that portion of the road may be placed under contract. It was ascertained that a good trace could be obtained there, and it was then thought more important to bestow what remained of our time in the country between Gorgona and Panama. It will require a good deal of additional labor to select the *best line* from Manzanilla harbor to the Chagré river.]

## 5TH—ISTHMUS OF DARIEN.

Intermediate between Chagres and the Gulf of Darien it has been supposed that a good line for a railroad or a canal might be found from Mandingo Bay to the Bay of San Miguel. In reference to these representations I visited Mandingo bay, and satisfied myself, from personal inspection and inquiry, that nothing was to be hoped for in that quarter, and that all that had been said about large canoes having been taken over this country, from the Atlantic to the Pacific, was *fabulous*. Occasionally a *pit-pan* (a small canoe that two men might carry) may have been thus transported; but nothing more. In fact, the Mandingo Indians, who frequently visit Panama, almost invariably go by the way of Chagre. An old and intelligent man told me that he once returned from Panama through his own country, but that it occupied "ten days for him to *catch* Mandingo" by that route. He described it as being extremely mountainous, as we could see for ourselves it undoubtedly was. There are no considerable streams flowing into Mandingo.

From the Gulf of Darien are three routes which have been advocated for connecting the two oceans; but I have seen nothing to satisfy me that they are anything more than plausible. All the information we have concerning them is general, speculative, and intangible. It amounts to this, that *somebody*, a *pilot* perhaps, passed over the ground and thinks the country is nearly level. The best information, after all, that we possess, is derived from the military expeditions which have traversed the isthmus, especially from the buccaniers.

In April, 1680, the pirates Sharp and Sawkins, crossed with three hundred and thirty-one men from the Gulf of Darien to the

Gulf of San Miguel, on the Pacific, on their way to attack New Panama. They give a very unfavorable account of the route over which they were guided by their Indian friends, and they describe it as being extremely rugged and difficult.

In April, 1681, Dampier crossed from the Pacific to Darien. It took him twenty-three days to perform the journey.

In 1670, after a gallant defence, a party of Captain Henry Morgan's men, under the command of Brodeley, captured by storm the formidable castle of San Lorenzo, at the mouth of Chagre river, 280 out of 314 of the garrison having perished in the onslaught; not a single officer having escaped alive. Nothing could have been more ferocious and desperate than the assault; nothing more noble and devoted than the resistance.

On the 18th of August of the same year, Morgan, with 1,200 buccaniers, marched up the Chagre, and after ten days of incredible toil and privation, having been compelled to eat skins, leather, and reptiles, reached Old Panama, which they took, sacked, and after perpetrating every kind of conceivable enormities, utterly destroyed. They were seven days in reaching Cruces, and, although it was during the usual wet season, there was no complaint of the rains, and the river appears to have been low. The expedition was accompanied by a Frenchman, who has written a history of it, in which he accurately describes the country and its productions.

In December, 1821, General Bolivar landed a large force at Limon Bay, and opened a road on the right bank of the river Chagre to Gorgona and to Cruces. The artillery and baggage were transparted by water, but the troops marched by land, some taking the road from Gorgona to Panama, and others from Cruces. This column was destined to assist in the expulsion of the Spaniards from Peru, which was accomplished by the glorious victory of Ayuchuco. Commodore Daniels, of Baltimore, commanded the fleet.

Another route across this isthmus is from the Rio Atrato, discharging into the Gulf of Darien, to the bay and harbor of Cupica, lying in the southeast of Panama, on the Pacific. This line was also suggested by the illustrious Homboldt, and has been strongly advocated by other writers. Mr. Wheaton, in his admirable despatch No 278,* to the State Department, says:

"At the time when Humboldt wrote, the geographical position of Cupica was very uncertain; but Berghaus has since shown, by the analyses of various astronomical observations, that it lies In seven degrees fifteen minutes north latitude, and eighty degrees six minutes and three seconds west longitude from Paris. From Cupica the traveller passes over a flat country, (terreno, enteramente blano,) very proper for the excavation of a canal, which, at the distance of five or six leagues, would unite with the River Naipi, or Naipipi, which joins near the village of Zittara, the

* See Rockwell's Report Ho. of Reps., Doc. No. 145.

great River Atrato, which flows into the Gulf of Darien. The navigation of the Naipi is impeded by cataracts and rapids, which, according to Captain Cochrane, would require a lateral canal to avoid them. The great chain of the Andes, according to this traveller, is here entirely broken off, and sinks first into hills and then into level plains between the Bay of Cupica and the mouth of the Atrato. But it would require a much more accurate knowledge of the country than we at present possess to determine the practicability of constructing a ship canal in this direction.

In connection with this matter, I subjoin an extract from Capt. Cochrane's journal, which would seem definitively to settle the question. Captain Cochrane was a highly intelligent traveller, and remained two years in Colombia, the greater portion of which was spent in exploring the country. He says distinctly that this communication, even if it were opened, could never become of great utility, from its distance, and the brief season of the year in which it is practicable :

"*March* 15*th*.—During the night passed the river Niapippi, which is badly laid down in the best charts, being at least one hundred and eighty miles below Citera, instead of close to it. This river is partly navigable, but the navigation very dangerous and unfitted for commerce ; and as for forming a canal or iron railway, it is impossible—at least, I was informed so at Citera, by Major Alvarez, a Colombian officer, who crossed over to Panama by that route. He said that he found the river Niapippi shallow, rapid, and rocky ; that the land carriage to Tupica was over three sets of hills, and that he could perceive no possibility of making a communication between the Niapippi and the Pacific ocean ; and from all the information I have been able to collect, I conceive that Baron Humboldt (who did not visit this spot himself) must have been misinformed on the subject of this communication with the Pacific Ocean."

## 6TH—OF THE DIFFERENT PROJECTED RAILROAD ROUTES TO THE PACIFIC, WITHIN THE TERRITORIES OF THE UNITED STATES.

This subject has been so thoroughly and ably discussed by Rockwell, Abert, Wilkes, Maury, Alexander, and others, that but little remains for me to say. In some essential points, however, with great respect for those gentlemen, and distrust of my own judgment, I am constrained to differ from them all. I do not believe that such a road can ever become a great *commercial thoroughfare*, and I much doubt if it would, when completed, for a century to come, more than pay its expenses. The lowest estimate I have seen for the cost of transportation per ton per mile is three cents. This would make the freight of a ton of merchandise from San Diego to St. Louis, or to Memphis, not less than $60, and to New York more than $90. The cost to the latter port by the way of Cape Horn would not exceed $20. I am aware that time is an important element in commercial transac-

tions, but is it worth the difference in money above stated? Is there, in fact, any merchandise except bullion, and *perhaps* very costly teas and rich silks, that could possibly bear that amount of expense on their freights? I should think not. For comparatively short distances such a road might be used to a small extent for the transportation of supplies for a very limited population. But large portions of it, whichever line may be selected, must necessarily pass through regions on which nature has indelibly affixed her curse of sterility, and which can support only a nomadic race, whose means are small and wants few. The topographical features are believed not to be unfavorable for the construction of a railroad, when its great length is taken into consideration, although long sections of it must necessarily be difficult, and the whole, in comparison with the same *amount* of work in the Northern States, very expensive, owing to the want of labor, of subsistence, and many of the means of execution in the vicinity of the line. The bridges would probably have to be constructed of iron. The cost of superintendence, repairs, and transportation on the best managed Northern railroads of the United States is usually estimated at about one-half of the receipts, the most profitable portion of which are derived from freights and way travel. On this road, where the fuel will have to be transported for long distances; where the freight and way travel will be extremely small; where there is great danger of large portions of the road (and especially the bridges, if built of wood) being destroyed by fires, kindled by accident or design; and where frequent interruptions may be expected from the Indians and the hunters, whose hunting grounds will be disturbed by the transit of the train, the proportional expenses must be greatly enhanced. It is known that fires periodically pass like "besoms of destruction" over the vast western prairies. These *fire tornadoes* have been described by eye-witnesses as most appalling, sweeping along with frightful rapidity, leaping over broad streams, and consuming every thing combustible in their progress.

I am not prepared, however, to say that there may not be great political reasons (involving the transmission of the mails, military defences, and the development of the resources of the country traversed) for the construction of such a road; and that it may not be the true policy of our Government to expend upon it $100,000,000, or even $150,000,000, and perhaps some $3,000,000 or $4,000,000 annually for expenses and repairs. These are considerations for the statesman, not for the engineer.

The most favorable route for a railroad from the Mississippi to the Pacific is, in my opinion, that described so minutely by Col. Abert, Chief Topographical Engineer, who has supported his project with his usual ability. It is to commence at San Diego on the Pacific, and to strike thence to the Colorado, following up its affluent, the Gila, to near its source; then passing into the valley of the Rio Grande del Norte, keeping within the jurisdiction of the United States. From this point the line would pass through

Texas to Nacogdoches, where Col. Abert proposes a bifurcation of the road—the one branch nearly direct to the Mississippi, above the mouth of Red river. A slight deflection from Nacogdoches would carry it to Vicksburg, or to Memphis, as might be deemed most expedient. "The northern branch will probably find its better course to cross the Red river at the great bend or its vicinity; then crossing the Arkansas at Little Rock, pursue its course to St. Louis; then crossing the river to pursue the most direct favorable course which can be obtained south of the great lakes, to Pittsburg." These two lines when actually traced, and the work finished, would probably exceed two thousand miles.

This route, with its bifurcations and adaptability to further lateral improvements and extensions, is, I think, much superior to all others, and is certainly less open to some of the objections which I have urged against them.

[Since the above was written I have read with care a very interesting pamphlet by J. Loughborough, Esq., of St. Louis, on the different railroad routes to the Pacific, in which he advocates with great zeal a line proposed by him from Missouri to the bay of San Francisco. This pamphlet is the result of much labor, and presents nearly all the information which is known on the subject, derived either from the personal observations of the author, which have been extensive, or from the explorations of others.]

Mr. L. says, "The portion of this route from St. Louis to the western boundaries of the State has been so much better described than we can hope to do it, by W. R. Singleton, Esq., in the last number of the *Western Journal*, that we shall here insert his observations, with the assurance to the public that they are the observations of an accomplished engineer, and one who is probably more familiar with the topography of this section of the State than any one living.

"After a careful examination, I at once pronounce it by all means the most practicable and economical to pass from St. Louis westwardly, until, by some small stream, the valley of the Missouri can be reached just above the Big Bonhomme bottom, thence around the slopes of the hills on the south bank of the Missouri to the Lamine; up the valley of this stream to Black Fork, to Davis's Fork, and thence on to the main or Lamine ridge, between Buck Knob and Wagon Knob, in Lafayette county; thence on said divide to Cool Spring and Lone Jack, in Jackson county; and thence, crossing the breaks of Little and Big Blue, reach the "plains," as they are familiarly called, on the Sante Fe road, at Black Jack Point. That this road can be constructed at a less cost than any other, all must admit. From St. Louis to the Missouri river but one small bridge is required; thence, twelve other small bridges to the Gasconade—a large one there; thence, three small ones to Osage—a large one there; thence, eleven to mouth of Lamine—total, twenty-seven small bridges,

average of one hundred feet, and two large ones. It is preferable, for two reasons, to use the valley of the Missouri; first, the grades will be uniform; and, second, the branches of any main streams will all be crossed at one point, thus avoiding the difficulties always encountered in crossing a country over the breaks of the drainage; thereby giving a zigzag grade to the road. In addition, the amount of water to be passed can always be done at one point much better and cheaper than in fifty or a hundred. Again, the Missouri itself will be avoided; whereas, on the north side, it must be crossed twice. That the south side of the Missouri is preferable is obvious; the amount of water received into the river from the north is much greater than from the south; almost all the streams on the north side head some distance in Iowa; and the whole drainage of the north half of the State is through the Missouri river; whereas, on the south half not more than two-thirds of it is drained by the Missouri. These are important considerations, and have influenced me in forming my opinion."

To coincide with the line indicated by us, the latter part of Mr. Singleton's section must be slightly varied to cross the Kansas river near its mouth.

From the mouth of the Kansas to the forks of Platte river this route ascends the fertile valley of the Kansas to Blue river, and follows that stream nearly to its head, from whence, in twenty-five miles, it strikes the Platte, near the head of Grand Island, and follows the valley of that river to its forks. This part of the route is absolutely free from impediments, and needs no grading, so admirably does it lie for a railway.

Crossing the South fork, where a bridge is requisite, it follows the North fork to Laramie, through a valley well nigh as level as a floor, and without crossing a stream, until it arrives at Laramie's Fork, which is about ten yards wide.

From Fort Laramie to the South Pass the road will need but little grading. Fremont says, "The road, which is now generally followed through this region, is a very good one, *without any difficult ascents* to overcome." He adds: "From the mouth of the Kansas to the Green River valley, (west of the mountains,) there is no such thing as a mountain road on the line of communication."

The South Pass is 7,490 feet above the Gulf of Mexico. August 13th, Fremont's descent in 24 miles was 22 feet per mile. August 14th, in 25 miles, 11 feet per mile. August 15th, in 29 miles, 15 feet per mile. August 16th, in 26 miles, 3 feet per mile. August 17th, in 21 miles, 3 feet ascent. August 18th, in 32 miles, about 15 feet ascent. August 19th, in 28 miles, about 6 inches per mile descent.

From the South Pass, the route would follow the line of a road habitually travelled by the traders, and called "Sublette's Cut-off," to the Soda Springs, situated on the northern bend of Bear river; and from thence it would pass a little south of west to the valley of Humboldt or Mary's river. This is the only por-

tion of the route not actually surveyed by Colonel Fremont. That enterprising officer travelled from the South Pass up a western tributary of the Colorado of the West, and over a dividing ridge, into the valley of Bear river, and followed that valley in the semi-circular course to the entrance of the river, into the Great Salt Lake, and thence proceeded westward, over some mountain ridges, to the valley of Mary's river. "Sublette's Cut-off" derives its name from the fact that there is a saving of 75 miles of distance from the South Pass to the Soda Springs, and upwards of 100 to the valley of Mary's river. It is also the preferable route, because the whole of the mountain ridges are entirely flanked from the South Pass to Mary's river, and the general course of a right line from St. Louis better preserved. On this part of the route but little grading would be required. The section from Soda Springs to the valley of Mary's river was traversed by a party of Bonnerville's men, and by Bidwell, and no mention is made of mountains or other impediments in his narrative. Besides, we have ourselves travelled the whole line as far as the Colorado of the West, and have seen more than fifty men who have passed from thence to Mary's river, and therefore speak advisedly on the subject.

Down the valley of Mary's river there is not a single canon which may not be easily turned, and for nearly its whole length there would be but slight labor in grading. Where the emigrant road strikes this river it is 4,700 feet above the sea, and at the point where it sinks it is 4,200 feet. The termination of this river is within fifty miles of the base of the Sierra Nevada, and opposite the Salmon Trout River Pass, which is only 7,200 feet above the level of the sea, and less than half that above the level of the basin. This pass is forty miles above New Helvetia, by which the route descends the valley of the Sacramento, directly through the gold region to the bay of Francisco, without any impediment whatever.

There are two other passes of the Sierra Nevada. One of these leads into the valley of the Sacramento by following Carson river to its source, and then descending the American Fork of the Sacramento ; and the other proceeds south from the sink of Mary's river into the valley of the San Joaquin, near its mouth. It may be possible that one of these passes will be found preferable to the Salmon Trout Pass, but that is uncertain, and as we have found a pass through which thousands of loaded wagons will go during the present season, and which has been found by Colonel Fremont to be practicable, our object is attained."

As public opinion throughout the country seems clearly to indicate a sense of the pressing necessity for some rapid and direct communication with our Pacific possessions, it is quite probable that a railroad, exclusively within our own territory, to effect this desirable object, will receive at an early day the sanction of Congress, and it may therefore be not out of place to advert, in this connexion, to the high importance of a speedy completion of one of

the short railroads across the American isthmus, not only with the view of answering a temporary purpose, for the transportation of passengers and merchandise, but also as a most useful (if not necessary) auxiliary in the construction of the greater work. We live in an active, utilitarian, and *impatient* age, and the present generation will not be willing to wait the slow, *ordinary* progress of construction in the opening of a road 2,000 miles long. When once commenced, it must be pushed to completion with all possible energy and speed, and one of the efficient means to ensure that result will be found, in my opinion, in an isthmus railroad.

In conclusion, sir, permit me to say that I am perfectly conscious of having very inadequately performed the duty which you have so kindly invited me to assume. Knowing the deep and abiding interest which, for more than twenty years, you have evinced in the question which I have undertaken to investigate, I was most anxious to meet your views, and regret that I have not been able to render them more ample justice. I have endeavored to condense this paper as much as possible, but feel that it is already much too long. With more leisure, I could have abridged it to advantage ; but the truth is, the subject is so vast and momentous that I found it to expand under my hands, and I scarcely knew when to stop.

Very respectfully, sir, your obedient servant,

GEO. W. HUGHES.

# APPENDIX.

## (A.)

OFFICE OF PANAMA RAILROAD COMPANY,
NEW YORK, *July* 20, 1849.

Col. GEO. W. HUGHES, *Chief Engineer.*

SIR: An estimate has been made of the cost of constructing this road from the crossing of the Chagres river, near Gorgona, to Panama, the work being of a description suitable for the heavy traffic which may be eventually expected; also, another estimate for a road between the same points, sufficient for the transportation of passengers, with their baggage and light freight; also a third estimate, in which parts of each of the above have been combined, avoiding the heaviest parts of the superior road, and substituting, with a view to its ultimate improvement, the inferior road, in the places where this heavy work occurs. I have, besides, carried on the estimates to embrace an extension of the road below Gorgona to San Pablo and Aqua Salud respectively, for the reason that obstacles exist to the navigation of the river at both those points, which it may be found inexpedient to remove, starting the road instead from the bank of the river opposite to them. The description of work, for each kind of road, will be explained in connection with the estimate.

The survey of the division of which I had charge covered the ground between Gorgona and Panama, and a thorough reconnoissance, made by yourself, of the whole region of country, gave strong evidence that we were on the best route, leaving nothing to be determined but the precise ground for the location, which could be settled by the minute surveys alone. In pursuing these surveys, a summit of 299 feet above the high water of the Pacific was found, and this is lower than any heretofore known. After this discovery, a consideration of the limited time left to pursue our labors, i. e. the continuance of the dry season, induced us to suspend further effort in seeking a still lower summit, and through the one found the lines of survey were carried. Subsequent explorations, however, furnished the knowledge that a lower summit existed in the same vicinity, but as the surveys in connection with it have not been made, our estimates are based on the line as run. I am, however, well persuaded, that so much of the line as has been modified by this new summit, some 5 miles in extent, will be quite favorably affected. The surface of the country over which our line passes may be readily described. The mountain chain which divides the isthmus, instead of being disposed in long high *ridges*, as is common in mountainous countries, consists rather of a series of hills. The passes among these hills, are unusually

low, and the streams which occupy them, have, in most instances, but small declivity to their beds, excepting when near their sources, or in the smallest tributaries. In some few cases, however, we *do* find ridges lying across our route, and when these rise suddenly from the streams which wash their bases, we are compelled to adopt high masonry and embankments to cross the valleys, and to cut deeply through the ridges. In one instance, viz., in passing the ridge between the Mandingo and Obispo rivers, we are compelled to resort to tunnelling.*

It may be conceived, that in a country like this, roads of very different degrees of excellence may be made to follow essentially the same route by a simple modification of the gradients and the radii of the curves. These modifications having been made, we are enabled to present the several estimates which I have mentioned.

After running many trial lines, we concluded to locate as follows: Beginning on the bank of the Chagres, near Gorgona, we struck directly for the summit, making no other deflections than the minute topography required. At the crossing of the Maria Posa river, three miles from Gorgona, we met a heavy bank, with deep cutting beyond; at about four miles we came to the Mandingo, a river with a long valley, (in fact its upper waters wash the base of the dividing ridge of the isthmus,) but, excepting in seasons of flood, discharging very little water, its bed is very low; half a mile beyond this, is a ridge running completely across the country, so high as to require a tunnel of from 850 to 1,000 feet in length. This ridge is a spur of the main chain, and cannot be turned. We reach the tunnel by an ascending grade of 40 feet to the mile; beyond this is the river Obispo, the bed of which is higher than that of the Mandingo by 50 feet. On the side of this valley we rise by a moderate grade of 20 feet per mile, crossing the Masimbar and other small streams, until we attain the gorge of the main chain of the isthmus, before spoken of as the summit of 299 feet above the high water of the Pacific. This point is $9\frac{7}{10}$ miles distant from Gorgona. Here we have a cut about 2,000 feet long, of which about three-fourths is rock, and the cutting in the deepest place 45 feet, (average about 35 feet.) Then beginning to decend in the valley of a Pacific stream, called the Rio Grande, at the rate of 50 feet per mile, we continue this descent to and beyond the crossing of the river Pedro Miguel, which is $2\frac{3}{4}$ miles from the summit, and over which we pass by a bridge 80 feet in height, and a corresponding embankment 1,000 feet in length. This 50 feet grade extends 6,000 feet further beyond the Pedro Miguel, giving an incline of 20,000 feet in length, in all. After this, we cause the grades to indulate to suit the surface of the country, (maintaining always the *ruling* grade,) crossing several small streams, of which the most important are the Caimetillo, the Cameron, the Doiminica, the Cardenas, and the Puente, until we reach Panama, which we do, with a total distance from the

* This would be avoided by adopting the new summit.

crossing of the Chagres of $20\frac{24}{100}$ miles. When near Panama, for about two miles outside of the city, the surface of the country is favorable, and any amount of depot accommodation may be obtained at small expense. The point selected for the terminus is just outside the walls on the west side of the city ; but other points have been examined and lines run to them, so that we may alter at discretion.

From the present terminus as selected, business may be done, as is usual on the Pacific, by lighters, but the terminus is located with reference to the future improvement of the harbor, which, when completed, will render it one of the best on the whole Pacific coast.

The general appearance of the country over which the line passes is, as before described, hilly and broken, excepting in the vicinity of Panama, where are open plains called savannas. The hills do not form continuous ridges, but rise in many detached peaks, and winding around the sides of these the line follows its course. These hills seldom exhibit rock, but are covered with dense vegetation to their summits. The undergrowth is everywhere very dense, but it is less difficult to remove than the underbrush of our country, particularly that of our swamps. There is more difficulty in making these clearings for the lines of survey than in clearing widely for the purpose of construction, because the growth is so interwoven that the labor of removing for great widths is proportionably less costly than in clearing for mere lines of sight. The timber is not generally heavy, although there are often large trees of hard wood, and the ground is filled with large roots, but no part of the line is swampy. About four-fifths of the distance from Chagres to Panama is through forest. From this we may judge of the charaeter and cost of the *clearing* and *grubblng*.

The *earth excavations* will be made generally in *red clay*, which is the common soil of the isthmus. This clay is compact, but I think not indurated—there is no appearance of hard-pan ; if there be any it will be found probably in thin strata above the rock ; neither was there any appearance of quicksand. It is possible that, as the excavations are made, sand or gravel may be discovered, but we have no evidence of its existence, excepting in the beds of the streams. *Blue clay* we did not see, and in fact there is little doubt that nearly, if not quite all, the excavations in earth will be made in the red clay I have described.

There is undoubtedly much rock, and though our opportunities for minute examination on this point were not great, we have sufficient evidence that in most of the deeper cuts we will encounter this material. I do not consider this an objectionable feature of the work, as the broken rocks from the cuts will furnish a good protection for the embankments against the effects of rains. I think that most of the rock will be hard ; generally trap or analogous formations. It is true, that there are surface indications of a softer rock, and perhaps near Panama we may strike the red

sandstone, but the probabilities are in favor of a vast preponderance of the trap, and it is safer in our estimates to consider it so. Limestone has been seen in the country, but not immediately on the line. The nearest known locality is on the Pedro Miguel, about eight miles from Panama, and very near our line.

I think the country gives abundant evidence of the existence of quarries of good and durable stone for building in the immediate neighborhood of all the prominent works of masonry on the line. The heaviest of these are the bridge over the Chagres, the culvert at Maria Posa, the bridge over the Mandingo, and that over the Pedro Miguel. In neither of these instances will the stone have to be hauled over a mile, and it is by no means improbable that the cuts in the immediate vicinity of these and other works may furnish sufficient stone at least for the *backing*. The quality of the masonry estimated is that commonly called rock-face, with well dressed joints throughout, of which the best roads in the northern part of the United States furnish the examples. All those parts of the bridges commonly exposed to water are to be laid in hydraulic cement, the remainder in good lime, mortar or dry. Arch culverts to be laid in cement below, and in lime mortar, with a portion of cement in those parts not commonly exposed to water.

*Brick.*—The earth of the isthmus is well adapted to the manufacture of brick, an article of great usefulness in that climate. Many constructions in brick, the work of the Spaniards, as well as others of a more modern date, are standing in a perfect state of repair. Fuel for burning is abundant, and it is certain that the article may be used to great advantage in the construction of the work.

*Lime* may be made in the country. Besides the deposites of limestone mentioned above, lime has been seen on the Chagres river at two points, one near Cruces and the other near Vamos Vamos ; and also at other more inland localities. I do not doubt that it will be found in many places after the beginning of the work of construction. On the Atlantic coast the coral rock has furnished the supply for the construction of the works of defence, while on the Pacific the shells and calcareous shingle and the coral furnish an ample supply.

*Hydraulic cement*, of which the quality depends so much on the *manufacture*, will have to be imported. Extra care in the packing should be required from the manufacturer, to secure this delicate material from the effects of the humidity of the climate.

*Sand*, an article so common elsewhere, is less frequently met with here than could be wished. It is true that the beds of streams will furnish a portion, and the work along the Chagres may be supplied from the bed of that stream. Near the Pacific the calcareous sand has been used extensively in the military and civil works, but between Gorgona and Panama sand cannot be obtained abundantly without expensive transportation.

*Wood.*—The dense forests still in their primitive state, which cover a great portion of the surface of the country, furnish an in-

exhaustible supply of a great variety of timbers. The range of size of the trees is so great, and the qualities so varied, that timber suitable for every purpose of construction may be selected at discretion. I have taken pains to obtain information on the timber of the country, and I give below what I have gathered. Mr. Roy, a mechanic at Panama, Captain Daniel George, a gentleman who has travelled over the greater part of the isthmus, and resided on it for twenty years, and Señor Manuel Hutardo, of Panama, engineer of the Cruces road, a gentleman of character, experience, and intelligence, have been my principal informants.

It will be seen that the names of the woods are nearly all local, and there is so little similarity to the woods to which we are accustomed, that I cannot attempt to classify them with our timbers.

1st. *Guachapalè.*—Is a large tree found in abundance; the timber has something the appearance of and is about as hard as oak. It is excellent under ground.

2d. *Macano* or *Cacique.*—Is a crooked tree, and generally of middle size, though sometimes large. It does not readily decay under ground or in the water. Stakes driven fifteen years since, and washed alternately by salt and fresh water, show no signs of change. It is abundant.

3d. *Espino Amarillo.*—Is *not very* abundant. Is good for constructions in water. The wood is of yellowish color, straight grained and easy to work; it is of light weight and not liable to decay, or to the attacks of insects. There are seven kinds of Amarillo, all of which are considered good timber.

4th. *Cedro Espino.*—This is a large tree, the trunk straight, and the timber not heavy. The heart wood alone is good, and this stands well in the open air, or under ground, as well as in interiors. It is the kind commonly used on the isthmus in making boards.

5th. *Cedro Cebolla.*—Large tree, rather crooked; in other respects similar to the Espino. The curate of a village on the isthmus assured Mr. Hutardo that the trunk of a fallen tree, lying partly in the water, had been used by his people as a bridge from time immemorial.

6th. *Cedro Amargo.*—Is a large tree, easy to work, and stands well in the open air.

7th. *Nispero.*—Is a large tree and not easy to work, stands well, when not exposed to sun and rain. Insects do not touch it, but it is liable to rot if exposed to the inclemency of the weather. It is esteemed for its resistance to transverse action. There are several varieties, amongst which the *Nispero real* and *Nispero de Montana* are most esteemed.*

8th. *Quira.*—Very fine wood, tree large, timber hard, heavy, and difficult to work; resists friction. It is much used.

9th. *Guayacan.*—Large tree, hard, heavy, and difficult to work,

* The Sapadillo is said to be identical with the Nispero, and there are frequent instances of the great durability of this wood. At the castle of San Lorenzo, near Chagres, and amongst the old works at Porto Bello, are great quantities, which have endured, under various circumstances of exposure, for half a century and over. The timber resembles the cherry of the North, about the same color, hardness, and weight. It is quite straight grained and a very fine timber.

but very strong; is much employed in building. Señor Hutardo says, that if left on the ground and exposed to the open air, it petrifies, that is, becomes a silicious stone, retaining the appearance of wood. The conditions on which this petrefaction depends are unknown. The figures of the apostles, which are in front of the cathedral, are of this wood. They are not less than from 35 to 40 years old. It is the same wood known to us by the name of lignum vitæ.

10th. *Algarobo.*—Fine large tree, hard and heavy wood, of red color. If properly seasoned it lasts many years exposed to the inclemency of the weather; it is very abundant.

11th. *Mangle Caballero.*—This wood is considered as good as nispero; it grows generally near the waters edge, is found in great abundance, and will give pieces from 35 to 40 feet long, and a foot square.

12th. *Alcornoque*—(Cork-tree.) A very large tree; will give large beams, and wears well.

13th. *Mal-vicino.*—Is so named, by the natives, from its extreme hardness and great size. The color of the wood is yellow. It is found in abundance, and, as it wears well, it is much employed in building, notwithstanding the great expense of cutting.

14th. *Caoba.*—Trees very large, wood not heavy, and easy to work, stands well under a roof. If not properly seasoned it becomes brittle; for this reason carpenters object to its use; it is mahogany.

15th. *Roblè.*—Trees large, wood not heavy, and easy to work, stands well in the open air. On the whole, it may be considered a good wood. There are two varieties; one of which is not much esteemed.

16th *Corotu.*—Very large tree, light wood; used for making canoes; not good for general purposes.

17th. *Cedro Bueno* and *Cedro Passaya.*—Are cedars, but the least esteemed of the species. They are, however, sometimes used.

18th. *Cubo—Mora—Copè.*—These trees are abundant but useless for the purposes of construction. *Quipo.*—The laurel, however, is tough and elastic, and, when dry, is used for masts. *Bongo—Laurel.*

19th. *Torro—Cocobollo—Nazareno—Narangito—Totuna.*—The first three woods named are very beautiful and are used in cabinet-making. The narangito and totuna are fine strong woods, fit for the purposes of the wheelwright. Totuna is white and resembles hickory; mortices made in it never split. The tree, however, is small and of irregular growth.

20th. *Cano Blanco.*—This *cane*, cut open and cleared of the loose fibres, furnishes the cheapest and the best known lathing in the country. Under a roof, if properly seasoned, it will stand 30 or 40 years without injury.

21st. *Espabé.*—Is never used: the natives make no use of it, although it is very abundant and the trees grow to a great size.

A Mr. McGregor once erected a saw-mill and cut great quantities of plank from espabé, but it was a failure, as no one would use them.

22d.—*Algagia—Nispero—Nazareno—Madrona de Montano—Amarillo de Guayquil.*—All these woods are much esteemed, because they can be safely made use of while the tree is still young, and measuring but five inches square. The young trees are very abundant, easily felled, and carried over any road with comparative ease. They can of course be got cheaper than similar scantling from a saw-mill. They resist well a transverse strain, and are particularly good for cross-ties.

It is assumed that all the woods described above are used, when properly seasoned, and that the heart wood alone is employed. The hard woods are, however, used, without much regard being paid to heart or sap, though this practice should be condemned. It is the universal opinion of the country, that the quality of the timber is influenced by the time of cutting, in regard to the age of the moon; and as the same opinion is prevalent in our own country, and in Europe, although regarded by engineers as fallacious, I will give the strongly expressed ideas of Señor H—— on the subject:

"It is a fact within my own observation that no wood should be cut before the moon is full. I paid little attention to this popular belief until I found, by experience, that such was really the case. Insects will attack wood that will not be touched by them if cut after the full moon. This is very evident, if the wood is of a light and spongy nature. Some vegetable productions will prove this in a most striking manner, thus. If our common thatch be gathered under a new moon, it will rot in a few months, and be attacked by worms, while it will last from fifteen to twenty years if gathered at the full moon. Those who many years ago built houses in this country, are now most particular in selecting their woods after this manner."

The best time for cutting timber is just before the dry months, as it may then season during those months; whereas if rainy weather succeeds the cutting of the timber, it becomes liable to decay.

As I before remarked, most of the above information is drawn from Señor Hutardo. I will add what I have derived from other sources, when not identical with the above.

Garella, a French engineer, who triangulated the isthmus, and surveyed a route for a canal across, discusses the *quipo*, *nispero*, *guayacan*, *manpove*, *cedro*, *mahogony*, and *caonchone*, but without giving much information valuable for our purposes. He remarks on the *nispero*, (which is assimilated with the *medlar* of Europe,) that it is exempt from the attacks of the cornichan and other destructive insects and worms. He observes that it is the most valuable now known or used on the isthmus for the carpentry of houses, and also that it lasts well in the ground, and has been

got out for the cross ties of a projected railroad in Jamaica. The *cedro* or cedar is used for planks and for canoes. It is not smilar to the northern cedar. *Mahogany* is used in carpentry, but is inferior to that of St. Domingo. It is abundant in the interior of the isthmus, and particularly on the Pacific slope. *Gyac* (guayacan?) is so hard that the natives do not cut it away from their clearings. It is used for the rollers of sugar mills. This is the lignum vitæ.

From Mr. Roy the information which I obtained is found in the lists above given; that from Captain George, and from other sources, I give below:

*Nuno* is a soft wood, like pine, and is called the best wood for canoes in the country. Captain George owned a canoe of this wood, made, like all their canoes, from a single tree, which was twelve feet wide and proportionally long. She was twenty years old when he bought her, but perfectly sound, and lasted a long time afterwards. She is well remembered in the country by the name of the "Trinidad." The wood is therefore considered proof against the attacks of insects, and not liable to rapid decay.

*Zorro*, or *Soro*, is a striped or mottled wood, of dark color, and quite hard. It is used for furniture, and also in carpentry, similar to nispero. The tree grows large, with few limbs, and is sometimes used for canoes. The timber would be good for cross ties.

*Amarillo Carbonaro* is the best wood for cross ties, resembling chestnut somewhat in its qualities. It is straight grained, works easily, holds a spike well, and is, moreover, abundant. There are seven kinds of amarillo, but that now named is the best.

Respectfully submitted, by your obedient servant,

W. H. SIDELL, *Principal Engineer.*

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(B.)

*Extracts from a Report to the Chief Engineer of Panama Railroad, by Dr. M. B. Halstead, Surgeon of the Survey. New York, August* 1849.

Sir: At a former date I gave you a brief report of the health of the surveying corps under your charge on the Isthmus of Panama, with a few general remarks in reference to the climate on that portion of the continent. Our experience at that time had been limited to the most pleasant, and probably to the most salubrious portion of the year, so that we were by no means capable of judging what the condition of things might be, when the rains commenced, and the earth and air were filled with moisture.

All former travellers had given such accounts of the terrible insalubrity of the land, that we looked forward with some anxiety to the month when the cool N. E. winds should cease, and to be succeeded by the sultry breezes, and fitful showers, that mark the

commencement of winter, *i. e.*, the rainy season. During the first months of our exploration, we were daily visited by the refreshing trade winds from the Atlantic, which detracted much from the ardent heat of an almost vertical sun; in *May*, these were followed by variable winds from the opposite quarter, S. and S. E.; the air became sultry and oppressive, with short but drenching showers of hourly occurrence: it was the commencement of the season we had feared so much. Although our parties were still at work, alternately drenched and exposed to the sun, which shone with intense power, for the first few weeks little increase of sickness was observed, still it soon became evident, that northern constitutions could not withstand working in the breathless atmosphere, from the mere languor and depression resulting from increased temperature.

The year in this as in almost all tropical countries is divided into two portions, the dry and the wet. The former is so called, because little or no rain falls during its continuance, from December until May; the latter, however, which is much the longest, is characterised by incessant showers; swelling the streams and rendering the country almost impassible. Two very singular phenomena have long been noticed, relative to these rains. The first is, they generally begin on the Chagres and the Atlantic slope many days before they make their appearance in Panama, on the Pacific side; and yet the two places are scarce forty miles asunder, nor are they seperated by high continuous ranges of mountains. The second is still more remarkable. About the twentieth day of June the rains cease, the clouds pass away, and the sun shines out bright, and cheerfully, as before, lasting from eight to ten days. The natives call this, "*el veranito de de San Juan*," the little summer of San Juan. These changes from dryness to extreme moisture cannot fail to have a very marked effect upon disease. In the months of summer, intermittent, and remittent fevers are most common: in June, July, August and September, when the streams are swollen and turbid with washings of the soil, and vegetable matters, dysenteries prevail: but it is not until November, when the sun acts with power upon the saturated earth and the material left by the receding waters, that miasma is exhaled in this, as in all other countries under similar circumstances, and that the severer forms of bilious fever are met with.

Location has of course much to do with the salubrity of towns and villages a most marked example is the difference that exists between Porto Bello and Panama. The one is situated at the head of a beautiful harbor, surrounded by high mountains, which not only prevent the wind circulating through the streets, but act as it were for immense reverberators to collect and retain the heat. So notoriously unhealthy was this place, during the Spanish domination, that it received the fearful appellation of "*la sepultura de los Europenos*," the sepulchre of Europeans. But how far this mortality may have been connected with

drinking and dissipation report *sayeth* not. Panama, on the Pacific, nearly surrounded by the ocean, enjoys an equality of temperature and salubrity of climate very remarkable so near the equator. Its population (city and suburb) is nearly ten thousand; in the year 1848, the deaths reported numbered only sixty-two. There are but few cities in the United States that can show a less mortality. Nor is Panama singular in its healthfulness. The little villages of *Cruces* and *Gorgona*, close upon the immediate line of the road to be constructed, with the large town of *Chorera* to the west, are alike noted. Epidemics are of rare occurrence, the yellow fever, (the vomito prieto or black vomit of the Spaniards,) that desolates the coast towns of Mexico on both oceans, has never been known on the isthmus; nor was that dreadful scourge the cholera seen there in 1832 : the present year, however, it has created sad havoc in Chagré, Porto Bello, and along the banks of the Rio Chagré, but its virulence seems to have abated before reaching Panama. It is perhaps worth remarking that the cholera was imported into Chagre. In the month of May, the steamer Colonel Stanton arrived from New Orleans with passengers ; seven had died on the voyage, and many were sick at the time of landing. A few days afterwards the cholera broke out in Chagré, committing fearful ravages, and every village or hamlet along the river banks at which these emigrants stopped in the course of their journey were successively visited by the disease. At Gorgona it raged with terrible vigor amongst the improvident and poorly clad natives. The whole surveying party was at that time collected in Gorgona, and were in the midst of the greatest mortality—they one and all escaped. The rationale I leave to those better acquainted with the history of cholera to deduce. I believe too this apparent exemption was also noticed amongst the Americans then awaiting passage to California.

The town of Chagré situated beneath high hills, on low wet ground, has shared equally with Porto Bello the reputation of being the most unhealthy place in the world ; the evening air was considered as fatal as the fabled Upas tree ; no white man could sleep a night on shore and live. What change it may have undergone in recent years I do not know, but of a surety many of the engineers and a host of emigrants slept night after night on both sides of the river, departing, as far as I am aware, without a single death from disease (other than the cholera) contracted there. Yet I by no means intend to assert that Chagré may not be unhealthy, more so than even Tampico or Vera Cruz, since disease will always prevail, and the most malignant miasma be generated amongst a people living so notoriously filthy and not unfrequently dissipated lives.

The topography of the isthmus is such as would lead us to infer a healthy climate. To be sure no high snow mountains are here to cool the air and add grandeur to the landscape ; the whole country, however, devoid of swamps, (excepting near the Atlantic,)

is a congeries of lofty hills and deep valleys, watered by clear streams, flowing over pebble bottoms; beside abundant springs of delicious taste and freshness. The banks of the Rio Chagré, with its bold hills of trap covered with trees and climbing plants, presents a scene of more than usual tropical beauty.

It would require far more space than the limits of this report allows, to give little else than a partial enumeration of the vegetable wealth nature has so bountifully lavished on this land. The country is one vast forest from ocean to ocean, and were the means of transportation opened, an immense revenue might be derived from the groves of mahogony, cedar, and lignum vitæ that abound amongst the mountains, with many woods that would be of great beauty for cabinet work, as the ebony, cocobolo, and jacaranda or bastard rosewood. Dye woods are not wanting. Fustic is abundant; Nicaragua and Brazil wood are occasionally met with, and logwood is said to grow along the coast. The indigo plant grows well, the product equalling in color the best East Indian; but want of energy amongst the people has prevented its cultivation for the purposes of export. Among trees the palms are an abundant class; from the lofty cocoa and the palma real, which produces wine and sago, to the humble palma portorico, whose delicate fan-like leaves furnish the material from which is manufactured the well known Panama hat. Although not serviceable as timber, yet, with the exception of the plaintain and banana, the palm is perhaps the most useful of trees to the native. Its trunk furnishes him the walls, and the long thick leaves the covering for his hut. From the strong wood of the cocoa he makes his bow, and the hard caña brava serves instead of iron to tip his arrows for war or the chase. The palma chunga gives him a fragrant oil for his lamp, and the cocoa furnishes both food and raiment. The plantain and banana "are well esteemed among the most valuable gifts bestowed upon the inhabitants of the hotter portions of the globe." Its easy culture and abundant produce, with its nutritious qualities, render it the main support of half the people. When roasted it serves as bread, when boiled as potatoes; dried and pounded into meal, it is mixed with the manihot to make the casava bread; the fibres of the stem are twisted into very strong cordage. An intoxicating liquor similar to arrach is obtained by distillation. "The average produce of a plantain is about thirty or forty pounds of fruit, but not unfrequently between sixty and eighty pounds; and as the Indian may reckon on four crops in the year, a single tree yields at least more than one hundred pounds of fruit in that time. There is scarcely any other plant that produces such a quantity of fruit on an equally small space of ground."

Although the soil is so fertile, yet agriculture has been sadly neglected. The cultivation of the cereals, wheat,* &c., has never been attempted. Corn and rice are the staples, repaying a hundred fold. Sugar cane, though more luxuriant than on the plan-

tations of Louisiana, is not made to produce sugar sufficient enough for home consumption. Coffees, the cocoa, cotton, yams, and sweet potatoes, may be had for the trouble of planting. The Peta plant, a species of agave, yields a flax as beautiful as the Pina, from which the Chinese manufacture a delicate grass cloth. In the market of Panama, nearly all the variety of delicious fruits belonging to the tropics can be seen. The pine apple, limes, oranges, with delicious mangoes and chirimoyas, sapotes, guavas, custard apples and alligator pears, grow wild or with little care or attention from the native. A long list of valuable timber trees might be added, but as little is known of the durability of most of them, when exposed to the combined attacks of air, moisture, and insects, I shall but speak of the few best known and most used—the mahogany, cedar, and lignum vitæ, have already been mentioned—the espabé, coro-tee, and the immense buttress tree of Humboldt, the "Bombax," whose vast girth rivals the chesnut of Ætna—one near Gorgona measuring one hundred and ten feet in circumference—are used in making canoes and bungoes. I have seen bungoes in the harbor of Panama that would carry fifteen to twenty tons. Some adventurous Californians even sailed for San Francisco in them. The Nisperos, a species of Mespilas—similar to the Medlartree of Europe—is much used in the construction of houses. It is hard and close-grained, and not very liable to be attacked by insects. Algaroba is most excellent timber, and very common; it is resinous, and endures exposure well. Cacique, "one of the finest and most durable woods of South America." "The Quejada, Quira, and Madroña are all fine large trees, with compact wood, and durable." "The scale of vegetation is immense, trunks of enormous thickness rise more than eighty and a hundred feet in height, their laps so closely interlaced that not a sunbeam can reach the rich soil underneath, which is generally so thickly covered with lower plants that one cannot take a step without first, axe in hand, hewing out a path." But not only does the soil sustain this great mass of vegetable life, the trunks of the trees themselves teem with parasites and creeping plants. The fragrant vanilla and the gorgeous form of orchides are every where met with—rare and beautiful ferns, Lygodiums, hang in graceful festoons, adding beauty even to the palm.

I have the honor to be, respectfully,

M. B. HALSTED,
*Surgeon Panama Survey.*

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* Capt. George says that the experiment of growing wheat was perfectly successful..—G. W. H.

(C.)

PANAMA, *May* 10*th*, 1849.

Col. GEO. W. HUGHES,
*Chief Engineer Panama Railroad*:

DEAR SIR: In compliance with your request I take pleasure in furnishing you with the following determinations made during my detention on this isthmus. I have been aided by Lt. Whipple and Mr. Nooney. The place of observation was the N. W. Bastion of the fortifications surrounding the city of Panama, and is North of the Cathedral 2.″75, and West of 6.″8 (in arc.)

Latitude, North 8° 57′ 12.″15
Longitude 5*h*, 17*m*, 57.6*s*, West of Greenwich.
Same in arc 79° 29′ 24.″4
Magnetic decl'n 6° 54′ 37″ East.
Dip, 32° 00′ 00″

Intensity, 0.87507, uncorrected for difference of temperature. Intensity at Falmouth, England, taken as unity.

The observations for latitude were made with a Zenith Telescope, with focal length of 42 inches; and those for longitude with a Telescope by Meers & Sohn of 56 inches focal length, and a small portable Transit by Troughton & Simms. The magnetic forces were observed with a Fox magnetic instrument.

The Longitude of Chagré, which I determined by the transportation of five Chronometers, in the steam-ship Northerner, from New York, is 5*h*, 20*m*, 05.4*s* west of Greenwich, or, expressed in arc, 80° 01′ 21″.

From March 22d to May 12th the maximum temperature was 89° Fahrenheit, which occurred April 25th. The minimum during the same period was 65°5 Fahrenheit, occurring March 27th and April 5th, 1849. The mean temperature during the same period was nearly 80° F.

I am, truly yours,
WM. H. EMORY,
*Bt. Major Corps of Topographical Engineers.*

NOTE.—On the 12th and 13th of April, 1849, the sun was nearly vertical at Panama.

# ERRATA.

| | | | | |
|---|---|---|---|---|
| Page 8, | 1st paragraph, | 16th | line, for | "province" read "ravine." |
| 10, | 2d " | 7th | " | "corrected" read "connected." |
| 14, | 1st " | 6th | " | "argillacious" read "argillaceous." |
| 15, | 3d " | 3d | " | "Livons" read "Lions." |
| 15, | 3d " | 5th | " | "reders" read "renders." |
| 17, | 4th " | 3d | " | "termnii" read "termini." |
| 18, | 3d " | 7th | " | "acute" read "accurate." |
| 19, | 1st " | 1st | " | "omotepe" read "omotopee." |
| 28, | 1st " | 4th | " | "popogayos" read "Papagayos." |
| 29, | 2d " | 26th | " | "carbonate lime" read "carbonate of lime." |
| 32, | 1st " | 9th | " | "northeasterly" read "southeasterly." |
| 33, | 3d " | 11th | " | "Gratun" read "Gatun." |
| 42, | 3d " | 3d | " | "H. M." read "H. B. M." |
| 47, | 4th " | 9th | " | "Buccaniers" read "Buccaneer." |
| 48, | 3d " | 2d | " | "Buccaniers" read "Buccaneer." |
| 48, | 4th " | 4th | " | "transported" read "transported." |
| 50, | 1st " | 28th | " | "train" read "trains." |
| 56, | 2d " | 33d | " | "Doiminico" read "Dominico." |

Appendix A, should have been headed "Extracts."