Scottish Geographical Magazine

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rsgj19>

Rewa River, Fiji

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Published online: 27 Feb 2008.

To cite this article: H. H. Thiele (1891) Rewa River, Fiji, Scottish Geographical Magazine, 7:8, 434-441, DOI: [10.1080/00369229108732472](https://doi.org/10.1080/00369229108732472)

To link to this article: <http://dx.doi.org/10.1080/00369229108732472>

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of the map are either drawn on this coating or photographically transferred to it. The engraver then scratches through the wax down to the brass with a needle. He next takes suitable types, and stamps in the names also down through the wax to the brass, and completes the matrix with the necessary amount of detail, which may be great or little. After verification and correction the matrix is ready for electrotyping. You who know the appearance of stereotype moulds will see that this resembles the mould of an ordinary stereotype or electrotype page. The mould is next covered with black-lead, and an electrotype taken from it, when all the punctures that have been made through the wax to the level brass plate come out level—the scratches as lines, and the type as lettering. It is then mounted on wood, and is ready to insert among type and be printed along with it.

I have tried to give you very roughly an outline of how maps are made from the beginning to the end, in almost the same form that actual necessity forced me to learn it for practical use.

REWA RIVER, FIJI.

BY H. H. THIELE.

(*With a Map.*)

It is with the view of contributing some useful information about a small part of Fiji that I take the liberty of laying this paper before the Royal Scottish Geographical Society.

During the last thirty or forty years several books have been published describing these islands and their inhabitants, but, without being exactly unfaithful to the subject on the whole, the authors have evidently written with a view to the sale of their books rather than for the purpose of imparting accurate and useful information. Dr. Seemann's *A Mission to Fiji* forms an honourable exception, but yet I cannot help thinking that if he had resided five or six years amongst the natives of these islands, the experience he would have gained would have led him to alter his opinion on several subjects relating to them.

The Fiji group consists of two large islands, Viti Levu (Large Viti) and Vanua Levu (Large Land), and upwards of 250 smaller ones, ranging in size from over 200 square miles (Taviuni) down to islets consisting of an acre or less of barren rock. All the islands together make up an area of about 7400 square miles, of which about 4200 square miles belong to Viti Levu, the island dealt with in this paper.

A cursory glance at a map shows that the island of Viti Levu is of an oval shape; it is about 97 miles long from east to west, and 67 miles across from north to south at its broadest part.

Although the island is of no great extent, its climate varies very considerably in different parts; generally speaking, the southern and eastern districts and the greater part of the interior receive plenty of rain, while

the northern and western parts, especially the coast-lands, are considerably drier. The mountain ranges, the general direction of which is from north-east by north to south-west by south, are highest in the interior, where they attain a mean height of about 3000 feet, and they cover a greater area in the western than in the eastern half of the island. The south-east trade-wind prevails for about two-thirds of the year; it comes from the ocean laden with moisture, and, striking the eastern sides of the ranges, sweeps up their slopes till it reaches an altitude where, owing to the fall in temperature, some of its moisture is condensed and falls in rain on the windward side of the mountains. The average yearly rainfall on the south-east corner of the island, at Suva, the capital, is about 105 inches; at Viria, further inland and closer to the mountains, 145 inches; and at Ba, on the north-west coast, probably not much more than half of the latter quantity. No very reliable meteorological observations have so far been taken in that part of the island, but it may be noted that irrigation has to be resorted to there, in order to cultivate sugar-cane successfully.

From the circumstances stated above it will be easily understood that the principal rivers must be found in the southern and eastern parts of the island. The Siga Toka is by far the most important river in the middle and southern parts, while the Rewa holds the same position in the eastern half of the island. The former enters the ocean on the south coast, at about $177^{\circ} 30' \text{ E. long.}$, and the so-called delta of the latter occupies the south-east corner of the island. Besides these there are two other rivers of minor importance, viz., the Navua, which, rising somewhere to the south-east of the centre of the island, pursues a southerly course till it reaches the ocean about midway between the mouths of the Siga Toka and the Rewa; and the Ba River, the basin of which occupies the north-western corner of the island. These four rivers are the only ones on Viti Levu of any importance to traffic. Numerous creeks are found all along the coast, carrying the water from the slopes of the nearest ranges to the ocean.

In the northern part of the island the watershed between the Siga Toka and the Rewa is formed by the so-called Dividing Range.

The length of the Siga Toka cannot be estimated with any approach to exactness, as it is not decided which of the many head-waters should be regarded as the main stream. It runs for nearly the whole of its course through deep gorges in the most mountainous part of the interior; only near the mouth do extensive fertile plains and sandy hills lie beside its banks. It is full of rapids, shallows, and deep holes, and a dangerous bar obstructs its mouth; it receives many affluents both from east and west, all more or less of the same character as itself. During the rainy season an immense volume of water comes rushing down this treacherous river, while in the dry season there is in many places not sufficient water to float a laden native canoe. That the scenery on this river is magnificent can easily be imagined: in the north the banks are mostly formed by steep and high walls of barren rocks, and the narrow river-bed is strewn with large and small fragments of conglomerate, thrown or rolled into it during volcanic disturbances, between and over which the

water rushes along with great speed, forming whirlpool after whirlpool and an endless succession of foaming cascades. Any one who has seen the "Elvs" of Old Norway cannot help being struck by the great resemblance, especially if the hour happens to be early morning or late afternoon, when a gloomy twilight increases the wildness of the scenery, and seems to add to the darkness of the water in the deep pools and bring into greater contrast the silvery whiteness of the countless little waterfalls. A turn of the river and, may be, the whole scenery is changed from a Norwegian to a thoroughly tropical one. You pass into a narrow valley, where tree-ferns, wild figs, and smaller tropical plants occupy every inch of ground, and the more sloping sides of the ranges on either side are covered with dense forest from foot to crown: you might fancy yourself in the interior of Guadeloupe, or some other West Indian island. Where fertile flats of sufficient extent to produce the necessary food for the inhabitants occur, native villages stand on the banks. The Fijians here, and on the mountains generally, are called "Koi Colos"; they were the last of all the tribes to submit to British rule, and even now the greater part of the interior is included in the so-called "Disturbed District," through which a white man can travel only by special permission from the Government.

Leaving the Siga Toka, I will now proceed to the description of the Rewa, which is the principal subject of this paper, as the river happens to run through the district of Viti Levu with which I am best acquainted.

In the north-eastern part of the mountain ranges lie the sources of numerous water-courses, which, with the exception of a few comparatively unimportant ones, make direct for the north coast, and join one of the two following rivers: the Wai-ni-Buka, the most northerly, and the Wai-ni-Mala. These, after very tortuous courses of some 30 miles, meet to form the Rewa. The length of this river is about 42 nautical miles,¹ and its general direction is towards the south-east. It receives numerous affluents both from the north and south, but only two are of any importance. These are the Wai-Dina and the Wai-Manu, both coming from the west. The former flows into the Rewa about 28 miles, and the latter about 10½ miles, from its mouth.

It may fairly be reckoned that the Rewa drains one quarter of the entire island of Viti Levu, or about 1000 square miles. Taking the average rainfall in this basin at 120 inches per annum, and allowing 25 per cent. for evaporation and absorption, this river carries yearly about 5800 million tons of water to the ocean. Evaporation must necessarily be small, where rainy and cloudy days are so very frequent and dry winds never occur; besides, probably half of the total quantity stated above is carried down during floods or heavy freshets—which last from three to six days at a time, and occur on an average about six times yearly—and soon reaches the sea. Nor can the quantity of water absorbed be very large, owing to the impermeable nature of the river-bed, for the hills, where they are not of hard rock, are principally formed of soapstone,

¹ When miles are mentioned subsequently, they are "nautical" miles.

which, once saturated, hardly ever gets the chance of becoming dry again. The same to a great extent is also the case with the clayey soil on the flats, and the peaty soil has quite a remarkable power of retaining moisture, owing to its resting on layers of clay and being covered with a thick vegetation of rank grass and reeds.

The effects of the force of this considerable mass of water making its way towards the sea shows itself in several ways. The river-bed gets deepened in some places, while shallows are created in others, banks are undermined and carried away, and the materials formed into islands elsewhere. These changes are continually going on, slowly certainly under ordinary circumstances, but with all the greater violence during heavy floods. In the five or six years I have been here the channel of deep water in the lower part of the river—from Dreke-ni-kelo to the sea—has altered to such an extent that in one or two places islands now exist where previously the deepest water was to be found. Immediately after a heavy flood or freshet the river on the whole gets shallower; in course of time, however, and especially as far as the tides take effect, a channel is formed of about the usual depth.

From Laucala bay to the Navolua mouth of the river the coast-line is formed by a succession of mud-flats, sandy stretches, and some fringing reefs: on the whole it is rather low, though a portion of it between Nasoata and Nasalai rises to an elevation of from 30 to 40 feet, and Kaba island is more than 100 feet over high-water mark. Mud-flats of varying breadth, more or less overgrown with mangrove bushes, line the bays and the banks of the lower portion of the river. The coast-line proper is in many places difficult to define, as the tides cause it to vary very considerably; in the accompanying chart it has been laid down on the line of ordinary high-water mark.

The difference of tides at the mouths of the river is about 3 feet under ordinary circumstances, and upwards of 6 feet during spring-tides. At Nansori, about 10 miles from the coast, the difference is $3\frac{1}{2}$ feet under ordinary circumstances, and $4\frac{1}{2}$ feet at spring-tides. At Naitasiri, 20 miles from the mouth, the usual tidal difference is $1\frac{3}{4}$ foot, with $\frac{3}{4}$ foot added at spring-tides. No tides are felt above the place where the Wai-Dina joins the river. Strong easterly or south-easterly storms increase the flood-tides to some extent. Seeing that the Rewa has six large mouths, it may be easily imagined that the tidal currents are very complicated in its lower portion, a circumstance which, combined with the effects of strong winds, considerably increases or retards the outflow of water. At the Nukulao, or principal, mouth of the river a sand bar has been formed with only about 4 to 5 feet of water on it at ordinary low-tide. A vessel drawing 3 feet requires $\frac{3}{4}$ flood-tide to go up river as far as Bau Levu. It is hardly conceivable with such tides, combined with the usual south-easterly wind blowing fairly on to this part of the coast, how a delta could ever have been formed. The depth of the sea outside the reefs is considerable, and also in the passages leading through the reefs; where the water is deep, mud is always found at the bottom, an indication that the sediment of the river ultimately settles there. The existing mud- and sand-flats were no doubt formed by the sediment of the

river, but they are all placed in localities well protected from the tides ; I do not think they are increasing in size on the whole, though no doubt small changes take place now and then. The higher ground at some parts of the coast mentioned above also tells against a delta formation, unless it can be shown that these hills were formerly separate islands, which in course of time have become one with the mainland. The really dry land is, as far as Rewa town on the three southern branches, not more than 2 or 3 feet above ordinary high-water mark, and even a very heavy flood does not cause an extra rise of one foot down here, although it may swell the river at Viria to 47 feet above the usual level, and some 18 or 20 feet at Nansori.

The Laucala branch of the river is the most important, owing to its being the shortest waterway between the capital, Suva, and the Rewa district, the most populous and best cultivated part of Fiji. The place where this branch breaks away from the main river is called Hellsgate ; it is a difficult narrow to pass through without running aground, as the channel is continually changing from one side to the other of the little island called Kata-na-elewa. Nearly opposite Hellsgate lies Rewa, the largest native town in Fiji ; it has a Roman Catholic chapel and also a Wesleyan church. The men are known as good canoe-builders, and the women make some of the best crockery ware in the whole group. Opposite the town the river is about 400 yards broad, but from here upwards it diminishes pretty regularly in width, the banks generally increasing in height. The land on both sides continues quite flat, and is cultivated by Europeans or natives, nearly all the way up to Nansori, where the first hills are met with. Mould resting on clay layers is the usual formation of the soil found on the flat land along the river banks. On the chart will be noticed a red dotted line drawn almost parallel to the river bed at Vuci-Maca ; this signifies an older bank of higher elevation. Such old banks are found in several other places, and even now they often confine the river during very heavy floods. The hills are nearly all of a uniform height (from 80 to 100 feet), and are evidently formed by pluvial denudation ; most of the fertile soil has been washed off them on to the plains or into the river, leaving exposed steatite (soap-stone) or some other heavy clay resting on a hard sedimentary base-rock. Trees grow well enough on them, but as yet they have not been much cultivated for useful purposes. Having become narrower and deeper just opposite the Nansori Sugar Mills, the river again widens out opposite Elliston, where a large sand-bank has been formed and is now half-covered with grass. Another old river bank, higher than the one at Vuci-Maca, commences near Elliston, and extends beyond the native village at Verata. A little further up, at Dreke-in-kelo, the river makes a very sharp turn to the westward, forming quite a right angle with its previous course. From the mouth to this point is called "Lower Rewa," from here to Bau Levu is "Middle Rewa," and the rest is "Upper Rewa." During heavy freshets a perfect whirlpool is formed at Dreke-in-kelo, and the depth of water on this spot considerably increased. Boats have no chance whatever of getting out, if once drawn into it, and even steamers under full speed have been carried round and round for hours

together. It is quite an amusing sight to watch the very mixed collection of floatables of different description, which is here kept dancing round in large and small circles. Native canoes are often torn away from their fastenings by the sudden rise of the river and carried away, but they never get beyond this place as long as the freshet lasts. From Nadurulolo the river has a comparatively straight course to Naitasiri; on either side the flat land is found in narrow strips only, and in several places bush-covered hill-sides descend to the water's edge. At Naitasiri a range more than 200 feet high commences on the right bank, and takes a westerly direction; on the opposite side lies an extensive flat between the river and the foot of the hills to the eastward. Owing to the tortuous course between here and Bau Levu, combined with a narrower bed and rocky bottom and banks, with generally a swifter current, the navigation requires considerable care and local knowledge. From Ban Levu to Vuni-cibi-cibi another large flat is formed between the river course and the foot of the hills on the right bank. Opposite Muanaweni the river for a short distance gets broader and very shallow; this is probably caused by the river water from above meeting for the first time the checking influence of a contrary tide: under certain circumstances the water comes to a stand-still, whereon many of the particles carried by it in suspension are precipitated. Above Wai-Dina, at a place called Viria, is the last flat of any importance: it is used, like most of the others on the lower river, for the cultivation of sugar-cane. A couple of days' steady rain in the mountains will often cause the river at Viria to rise 30 or 40 feet, and it has been as high as 50 feet above the ordinary level. With the exception of a few patches of land on which the natives grow bananas, there is no cultivation on the Rewa above Viria. No steamers go beyond this place, and canoes only are used for traffic further into the interior. The river from here upwards keeps a pretty uniform width of less than a hundred yards; on both sides the banks are formed by the slopes of bush-covered hills, seldom more than 100 feet high; low islands formed of coarse gravel are numerous, and about half-way between the Wai-in-mala and Viria the first rounded pebbles and stones are met with in the river-bed. The land of the surrounding district has not yet been surveyed, and the exact courses of the numerous creeks are therefore still unknown: this must be borne in mind when looking at the chart, where only their junction with the main river is given. Most of them drain hills and valleys many miles away, but, as I could not give their precise course, I have not shown any.

The distances to which under ordinary circumstances the different materials are carried away in suspension or pushed along the bottom by the river water are rather distinctly marked on the Rewa. Stones do not reach Viria; coarse gravel settles between there and Nadurulolo, finer gravel and sand are found in the Lower Rewa, while the mud is carried down to the sea. I do not mean to say that there is no mud in the river-bed, or no sand in the Middle or Upper Rewa, but that no final settlement of these finer substances takes place until after the water has lost power to move stones or pebbles and carry gravel in suspension. Where mud is found in the river-bed it is still, though perhaps slowly, in

motion towards the coast; the ebb-tide brings a large quantity with it to the sea, but the flood-tide also carries a considerable quantity of mud and sand, which had nearly reached the coast, up-river again. Thus many of the finest particles held in suspension by the water probably have to pass down and up the part of the river affected by tides a couple of times before they ultimately reach the ocean.

It is worth notice that on the flats the land close to the river banks is generally higher than that further away; when, therefore, floods occur here, they are not caused by the river overflowing its banks, but by the swelling of creeks near the foot of the hills, or by the water flowing from the river into the back-land through the same creeks, which under ordinary circumstances bring water to the main stream. As an average result of a good many trials at Nansori during a flood, which caused a rise of about 18 feet over ordinary water, I found that the speed of the current in the middle of the river did not exceed $4\frac{1}{2}$ miles per hour. At the same time the matter held in suspension was $\frac{1}{1000}$ by weight; this is about ten times more than under ordinary circumstances. These figures were obtained by weighing a quantity of river water and finding the weight of the residue after evaporation.

The only evidences of active volcanic action in the Rewa basin are some hot springs in the Wai-Dina, too far to the westward to be shown on the chart. I have not seen them myself, or been able to obtain a reliable detailed description of them.

The scenery on the Rewa is totally different from that on the Siga Toka: there primeval Nature displays a grand variety of forms; here almost everything has been interfered with by the hand of man. Signs of civilisation are met with everywhere in the form of well-built cottages, with pretty gardens, and large plains planted with sugar-cane. Steamers, cutters, boats, canoes, and bamboo rafts are continually on the move; permanent tramways, worked with locomotives, have been constructed at Nansori, Naitasiro, Bau Levu, and Viria; and at Nansori for six months of the year the electric light turns night into day. Even the hills have not been spared, and a tunnel through a range at Viria allows sugar-cane grown along the Wai-Dina to be transported by rail to the Viria Mill. Above this place Nature holds the sway; the scenery, however, is very monotonous; nothing but bush-covered hills, where the trees are so hidden by creepers that it is almost impossible to determine their species; here and there fern-trees vary the general effect by thrusting their graceful fronds high above the other vegetation. Coco-nut palms, so conspicuous and numerous on the lower river, are very scarce up here, for they love sea air and salt water, and do not thrive far from the coast.

From the above description of the Rewa the following main points may be selected:—(1) The headwaters of its principal affluents have their springs in a very mountainous district of decided volcanic origin. (2) The basin generally consists of a series of irregular ranges or isolated hills of argillaceous composition, with alluvial flats between them or along the river banks. The coast is protected by coral reefs, with openings corresponding to the different mouths of the river.

A few words about these coral reefs may not be out of place here.

It is generally supposed, as stated by Darwin, that Viti Levu is one of those islands which are gradually being submerged, while their barrier reefs are being built up as fast as the dry land disappears. I trust, however, it will not be looked upon as presumption on my part if I state that I am of a different opinion. To support the conclusion I have arrived at, I would point out—

(1.) At Ovalau, an island about fifteen miles to the north of Kaba, the reefs are exactly of the same description as those at the mouth of the Rewa; in fact, they may be considered a continuation of the latter, interrupted in two places only by narrow channels. Opposite the port of Levuka, on the east coast of Ovalau, there is a passage through the reef which admits a considerable sea during strong easterly winds: the coast opposite this opening is in some places formed of hard conglomerate rock, which for a considerable distance along the shore has been thoroughly undermined and eroded by the action of the sea, at a height of two or three feet *above the line* at present reached by the water during spring-tides.

I consider this a decided proof of emergence, and, if Ovalau is rising, it is highly improbable that Viti Levu is sinking.

(2.) The coral reefs on the south-east coast of Viti Levu are exposed too long above water during ebb-tide to be "growing." Some parts of the reefs are exposed at half-tide.

Such are my principal reasons for believing that the island has been slightly rising in recent times, though it is hard to say whether it is still rising or stationary.

For Rewa district this is an important question. If the river navigation should become considerably more difficult than at present, a railway between this district and Suva would become a matter of necessity for the transport of sugar to the mills.

The accompanying chart cannot boast of artistic execution, but I think it will be found *quite* correct.

Note.—In pronouncing Fijian words the following rules should be noted :—

Letter *a* is pronounced as in the word *lamb*.

<i>b</i>	„	as <i>mb</i> ; <i>Bau</i> is pronounced <i>Mbau</i> ; <i>Ba</i> = <i>Mba</i> .
<i>c</i>	„	as <i>th</i> ; <i>ca</i> „ <i>tha</i> .
<i>d</i>	„	as <i>nd</i> ; <i>Dina</i> „ <i>Ndina</i> .
<i>e</i>	„	as <i>a</i> in <i>fate</i> and <i>late</i> .
<i>g</i>	„	as <i>ng</i> ; <i>gaga</i> is pronounced <i>nganga</i> .
<i>i</i>	„	as <i>e</i> in <i>me</i> .
<i>q</i>	„	as <i>ngg</i> : <i>Koroqaga</i> is pronounced <i>Korongganga</i> .

PROCEEDINGS OF THE ROYAL SCOTTISH GEOGRAPHICAL SOCIETY.

A SPECIAL MEETING of the Society was held in Edinburgh on the afternoon of Friday the 17th July. Mr. A. L. Bruce presided. A paper on "Matabele-land and Mashona-land" was read by Mr. Denis Doyle, who was accompanied to the platform by Gungunhana's envoys, Huluhulu and Umfeti. Dr. George Smith moved the vote of thanks to the lecturer.