Scottish Geographical Magazine

Publication details, including instructions for authors and subscription information:

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

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Robert W. Felkin M.D., F.R.S.E., etc.

Published online: 27 Feb 2008.

To cite this article: Robert W. Felkin M.D., F.R.S.E., etc. (1891) On acclimatisation, Scottish Geographical Magazine, 7:12, 647-656, DOI: [10.1080/00369229108732499](https://doi.org/10.1080/00369229108732499)

To link to this article: <http://dx.doi.org/10.1080/00369229108732499>

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extensive, is only an approximate. I may mention in this connection that I have measured distances on the Admiralty charts, which are all on Mercator's projection, between distant points, for determining the length of telegraphic cables; and when these distances were afterwards actually measured, by the number of miles of cable laid, I have never found them to be in error. At any great distance from the Equator, Mercator's projection greatly exaggerates the lengths of the degrees of latitude and longitude, and therefore gives a false notion of relative areas, and for this reason a modification of the conical projection may be preferred in some cases, but by the well-known system of "squaring in" the work on the Mercator's projection can be transferred to another map, where it will be shown in its true proportions. Time will not permit me to dwell further on this subject, or I could give other reasons for my preference, for rough survey work, for this useful projection.

I have now brought my paper to a conclusion. I have endeavoured to touch, however lightly, on the art of observing as it should be practised by travellers, and in this connection I would remark that it is greatly to be deplored that many of the well-educated and intelligent men who visit little-known countries, fail to make themselves acquainted with the manner in which observations, for fixing their positions, should be taken and recorded, the consequence being that, instead of contributing valuable information to geographers, they have frequently nothing more to tell us than that they have made big bags of game, and have seen lakes, rivers, and mountains, the positions of which on the map they can only assign by guess-work. As regards two of the instruments to which I have referred, the plane table and the compass, I feel sure that surveying in the field with them would form a valuable branch of instruction in our schools, and would give pupils a more perfect knowledge of the manner in which maps are made, and surveys are carried on, than they can gain in any other way.

ON ACCLIMATISATION.

BY ROBERT W. FELKIN, M.D., F.R.S.E., ETC.

(*Read at Meeting of British Association, 1891.*)

FOR many reasons the subject of acclimatisation is an important one, and its interest increases yearly. New areas are coming under European influence, and statesmen are naturally anxious to know of what use they will prove; whether they will only be useful in a strictly commercial sense, or whether colonisation will be possible, and if so, where and to what extent? Again, the World's population is rapidly increasing, and, according to the paper which the President of this Section, Mr. E. G. Ravenstein, read before this Association in Leeds last year, unless some great catastrophe happen, we may look forward to a time in the comparatively

near future when the population of the World will be so great that it will be almost impossible to obtain subsistence, even should the whole area of the World become inhabited by an evenly distributed population.

During the last few years the subject of acclimatisation has been frequently referred to. I would call to mind the paper read by Dr. A. Oppler before this Association in 1887; Mr. Ravenstein's paper on "The Lands of the Globe still available for European Settlement," read in 1890; a paper read by Sir W. Moore before the Epidemiological Society in January this year, "Colonisation of Central Africa by Europeans;" a paper I myself read on the same subject at Birmingham in 1886; a paper published by Professor Virchow in the *Zeitschrift für Ethnologie* 1885, accompanied by an important discussion in which Bastian and Fritsch took part; a communication on the "Acclimatisationsfähigkeit der Europaer in Asien," by Professor A. Sprenger, published in the same journal. The subject of acclimatisation is also referred to by Herr Joest in a paper on his journey in Africa in 1883 (*ibid.*); and in 1886 various other important communications were published in the *Zeitschrift für Ethnologie*, viz.:—a paper by Dr. Beyfuss on "Die Acclimatisation der Europaer in Niederländisch-Indien;" one by F. Jagor on "Der Sterblichkeit der Eingeborenen und Europaer in Ost-Indien," which was followed by a discussion; and a very important paper by Dr. August Hirsch on "Acclimatisation and Colonisation." These are all I need mention.

I find it, therefore, very difficult to say anything fresh on the subject. This is my misfortune, not my fault: I would not myself have chosen to introduce this discussion; but, having been requested to do so, I will endeavour to indicate what acclimatisation is, and what the difficulties of acclimatisation are, and I must apologise if I only echo much that has been said before.

When we look at the opinions that have been expressed on the subject of acclimatisation, we find that we can divide them into two schools of thought—one regarding acclimatisation as impossible, which view is supported by Virchow, Hirsch, Fritsch, Ravenstein, and others. Without going into detail, they hold that Europeans can never become acclimatised in the full sense of the word in Tropical regions, thinking that the deterioration caused by climatological factors and endemic diseases will invariably either kill off the emigrants, or at any rate render their ultimate existence impossible. Others, as De Quatrefages, hold that Europeans can become acclimatised anywhere. They, however, allow that the process of acclimatisation will be accompanied by severe loss, and will only occur after several generations. Others again are far more sanguine, such as Livingstone and the late Bishop Hannington, who thought that rapid acclimatisation in Tropical regions is possible for Europeans. I may state at once my own view of the subject. It is that, although we have at the present day examples of nations who have become acclimatised in areas far from their original habitat, hundreds of years have been required, and an immense mortality has accompanied their migrations, and it has only been by a process of the survival of the fittest that this acclimatisation has been possible at all. I believe, however, that our increased knowledge of climatology and of hygiene has rendered the problem more easy of solution.

Given picked individuals, and the careful selection of tropical areas in which to colonise, I see no reason why, with precautions, Europeans should not colonise even in the Tropics; if he

“ . . . Study well the clime,
Mould to its manners his obsequious frame,
And mitigate those ills he cannot shun.”

I may mention in passing that a very careful selection would need to be made, and that persons with a tendency to gout or rheumatism, diabetes or albuminuria, those with a nervous or alcoholic family history, or those suffering from either acquired or hereditary syphilis, should certainly be rejected.

When speaking of the subject of acclimatisation with reference to Europeans, we are very apt to fall into the error of imagining that all Europeans can be acclimatised or will resist acclimatisation in any given area equally. This is undoubtedly a mistake, for a marked difference obtains between northern and southern Europeans in this respect, and not only the climatology of their original residence must be taken into account, but also their habits and customs and their psychical peculiarities; and if these factors have to be considered with regard to the adaptability of a nation for emigration, so too with regard to the individuals of any nation. It is a fact that selected individuals from nearly every European nation may thrive almost all over the world. It has been denied that environment influences the human species, and it has been said that nations seek out that environment which is best suited for them. These statements I feel bound to deny, and I would say that environment definitely influences not only individuals but nations. This Herbert Spencer has shown in his *Principles of Biology*, where he demonstrates that every organ and every function of living beings undergoes a certain and definite modification within certain limits under the stimulus of new conditions; and he further opines that this modification is almost always such as to produce an adaptation to a new environment.

Broadly speaking, it must be admitted that Europeans can only become readily acclimatised in the Temperate Zone, that is to say, where climatic and other conditions are approximately akin to their present habitat. We may say too that the people who inhabit the Temperate Zone become more easily acclimatised in countries towards the north of their present habitation; and this is shown by the fact, if we are to credit it, that during the past 2000 years the Aryans have penetrated from the Tropics to the region of ice and snow within the Arctic Circle. Apart from this, however, as Mr. Ravenstein has shown, “if the white man is ever to occupy permanently the Tropical parts of the world, it will have to be done by stages, each stage making a generation of men. We well know that the peoples of southern Europe, such as the Italians and southern Frenchmen, can better bear the climate of sub-Tropical Africa than can northern Europeans. A steady stream of migration is, in fact, setting in that direction. Germans and Belgians are pouring into France, Frenchmen are going to Algeria, the Arabs from the shores of the Mediterranean have found their way into the Sudan, whilst the Sudanese are pushing forward into

Bantu Africa. A similar movement is going on in southern Africa. The descendants of those Dutchmen who, a couple of hundred years ago, first settled at the Cape, have made their way to the Transvaal, and European migration, favoured by geographical features, is being pushed even within the Tropics towards the Zambezi." With this I quite agree, and would once more call attention to the fact that wholesale, immediate acclimatisation for Europeans in Tropical regions is entirely out of the question.

There is little doubt that southern European nations would be able to colonise in the Tropics were the physical constitution alone to be taken into account; but temperature also plays a definite rôle in the possibility of prolonged existence in a given region, and it is a quality which especially requires time to be modified to new conditions of life. Hereditary temperament and capacity of mind variously characterise all nations, and differences of intellectual and moral power are well-marked factors in the possibility of acclimatisation. It is these factors which to a great extent limit the power of southern Europeans to thrive in the Tropics, whereas northern Europeans, though physically less able to withstand Tropical influences, are yet in possession of a more stable temperament, and greater strength of character, which will go far to enable them to overcome the difficulties incident to a sojourn or a settlement in the Tropics.

The acclimatisation of Europeans in the Tropics can only be successful if migration occurs step by step; and in estimating the possibilities of acclimatisation we must count by generations rather than by years. In 1861, it is true, Dr. Hunt denied this, saying that "time is no agent," and "if there is no sign of acclimatisation in one generation there is no such process." This, however, cannot be accepted, because there are many instances to prove the contrary.

What happens with regard to animals? We know that they can be acclimatised, and we know how their bodily structure is modified in order to enable them to adapt themselves to a new environment. It is not necessary to quote instances, they are so well known, but the following quotation from the last edition of the *Encyclopædia Britannica* shows the practical way in which an animal or plant may be acclimatised in a country very dissimilar from that of its native habitat, and where it has been experimentally proved that the species in question cannot at once live and maintain itself:—

"1. We must transport as large a number as possible of adult healthy individuals to some intermediate station, and increase them as much as possible for some years. Favourable variations of constitution will soon show themselves, and these should be carefully selected to breed from, the tender and unhealthy individuals being rigidly eliminated.

"2. As soon as the stock has been kept a sufficient time to pass through all the ordinary extremes of climate, a number of the hardiest may be removed to some more remote station, and the same process gone through, giving protection if necessary while the stock is being increased, but as soon as a large number of healthy individuals is produced, subjecting them to all the vicissitudes of the climate."

It is obvious that we cannot deal with men exactly in this way, yet

there is no reason why robust and healthy individuals should not be chosen for experimental acclimatisation, and why areas should not be sought out, even in the Tropics, where the climatological conditions are not altogether unfavourable to the success of the experiment. Such areas are to be found.

We must now try to ascertain what we know of the results of attempts at colonisation by Europeans in the past. As Dr. Oppler pointed out at Manchester—"of 80 million Europeans and their descendants who live at the present time, no fewer than 10 millions have found a home within the Tropics (or rather within the isothermal lines of 58° F.). Of these 10 millions, fully 9 millions live in Tropical America."

We find that the Dutch adapt themselves to a Tropical climate; they live quiet and temperate lives, dressing lightly, doing their work in the early morning hours, paying great attention to the drainage of the district they inhabit, and to their sanitary surroundings. At the Cape of Good Hope, where they have been, so to speak, isolated for the last 200 years, and where they have intermarried very slightly, they are tall and robust, they have retained their fair complexion, and, so far as physical development goes, we may say that they leave nothing to be desired. They marry at an early age, and their families are large. This is proved by the increase which has taken place, for we find that, whereas in 1798 they were under 22,000, in 1865 they numbered over 180,000. Again, we know that in Tropical South America, Europeans have become acclimatised, and when the race is kept pure they seem to improve in all respects.

If we desire an example of a race thriving in extreme vicissitudes of climates, it is to be found in the Indians, who, coming from a Temperate region in North America, have become acclimatised in the hot dry coasts of Peru, and also in the extremely cold regions of the Andes, at an altitude of from 4000 to 6000 feet. Now, notwithstanding that the inhabitants of these two regions do not thrive if they are removed from one to the other, they have nevertheless proved the possibility of an original race becoming gradually acclimatised in areas which are totally different from a climatological point of view.

As Professor Virchow pointed out in 1885, we have two questions to consider. The one is—Can an individual become acclimatised? the second concerns the acclimatisation of a race. With regard to the first question, we have to ask—how long can an average and healthy European withstand a foreign climate? to what extent can he become accustomed to it? for how long can he adapt himself to his new environment, and in what measure is he capable of manual labour there? In reference to the second question, we have to ascertain if and how it is possible for a European emigrant to found a family, and so to adapt himself and his children to his new environment that they can permanently exist there? These questions are by no means easy of answer. As to the first, it is perfectly true that some picked men removed from Europe to the Tropics do particularly well. They do not suffer from the heat; malaria seems to have no power over them; they sleep well, notwithstanding the noises and nuisances of a Tropical life; and we find, as Sir William

Moore points out, that "some grow stout and some grow thin" and yet appear to adapt themselves individually to any climate. They experience good health, they are capable of any and every kind of work, and at a good old age they return to Europe apparently uninfluenced by the climatological vicissitudes to which they have been exposed. These individuals appear to possess more than the average of *vis vitæ*; and it is from them, in all probability, that the best Eurasians spring. Looking to India, I suppose it must be admitted that the Eurasians are not a degraded, miserable stock; but, superior to their mothers in mental characteristics, they are also superior to their fathers in physical development, in staying-power, and in vitality. This leads me to a remark, in passing, that it would be a great advantage were this class of Eurasians in India well cared for by the Government, and were legalised marriages between the two races encouraged, and the children of such unions fostered.

Dealing next with our second question, we are met with insuperable obstacles in coming to even an approximate answer. The main difficulty rests with the want of statistics; and although we find in Cuba, for instance, and in Jamaica, that there is an apparent increase in the European population; yet we cannot be sure that this increase is due to the increase of the acclimatised individuals, or whether it is not a fallacious increase due to an incessant influx of southern Europeans. These are all points which I have only briefly touched upon in order to open the way for a discussion on the subject, and to elicit if possible definite and instructive data.

It is surely a sign of the times that even insurance companies are not now averse to taking the risk of a Tropical residence. What would have been thought of an office fifty years ago which was willing to take such risks? Now, however, we find that one so important and well known as the "Standard" will insure men going to reside in India, Ceylon, the Straits Settlements, China (Shanghai, Hongkong, Peking, and all the Treaty ports), Japan, West Indies, and the Mauritius. This office has stood the test of time, and it is impossible to suppose that its managers would enter into such business were they not sure that the time had come when the probabilities of life in the Tropics were as capable of being estimated as they are at home. As a matter of course an "extra" is charged; but even so, it proves that residence in the Tropics is not so uncertain, so fatal, as it once was. A well-known actuary told me the other day that even with regard to the Congo Free State, he estimated that the extra to be charged was 10 per cent. This "extra" is certainly heavy, but "coming events cast their shadows before."

It is unfortunate that in this investigation so much must rest on supposition and deduction, and that we have so few definite statistics to guide us. Even with regard to the Anglo-Indian army, we have only systematic sanitary reports since 1865; hence, in considering Indian statistics, and the light they throw upon the health of Europeans in that country, we can only take as approximate the figures at hand. This notwithstanding, we find undoubted evidence that the mortality of the troops in India has decreased remarkably in recent years. In 1820, the

annual loss per thousand was 80 (I take these figures from a paper published by Surgeon-General Sir William Moore); in 1856 the loss was 58 per thousand. But, as Sir William points out, "in those days men were not invalided home with the liberality which now obtains; and when ordered home for change, they had to wait perhaps months for a ship going round the Cape, for there were no Indian troopers, and the Suez Canal was not constructed. Yet invaliding at this period raised the total loss to the service to 69 per thousand." The average loss from 1870 to 1879 inclusive was,—invaliding 43 per thousand, the death-rate 19·34. This rate was still further decreased in the succeeding nine years ending 1888, when the average invaliding was 34 per thousand, the average death-rate 16·03. But, as Sir William Moore again points out, this rate of mortality and invaliding is still far too high, and depends chiefly upon the immature soldiers who are sent to India. Surely the short-service system has much to answer for in this connection, for it is an admitted fact that soldiers should not be sent to the Tropics until they are fully mature, that is to say, between the ages of twenty-four and twenty-five.

However, the reduced death-rate proves that much has been done to rob a residence in the Tropics of its terrors, and, to my mind, it also indicates a time coming when science will render a more prolonged or permanent residence within the Tropics a practical possibility.

Of course, it is climate which exerts the greatest influence on mankind. As Forray says, "Climate constitutes the aggregate of all the external physical circumstances appertaining to each locality in its relation to organic nature;" or, in other words, H. T. Buckle says, "It is the influence exercised by physical laws over the organisation of society, and over the character of individuals."

The salubrity of a climate depends generally and chiefly upon (a) a moderate and comparatively equable temperature, (b) on a certain dry condition of the soil, (c) as Mühry pointed out, "in a minor degree on certain unknown 'endemi-physical' predispositions to peculiar morbid conditions."

In order to attain acclimatisation, in a hot climate we must have (a) an alteration in the quantity and quality of the blood to render it adapted to the needs of the individual (physiological anæmia). This can be, and usually is, attained in two years. (b) A climate is, we know, only healthy or unhealthy as regards the individual, as may be briefly illustrated by southern Europe being used as a health resort for phthisical patients; but in this connection races have a certain immunity from some diseases. Thus, Negroes do not suffer excessively from malaria, provided they remain in their own districts; but should they be brought to Europe, cold tries them greatly. (c) We must also take into consideration that, in the Tropics, some places are healthy, others unhealthy; for, as Lind said long ago, we can always, with due care, find comparatively healthy areas in any part of the World.

In considering Tropical climates, with reference to health, we must not forget that, although in some places the mortality is very high, it is so also in Europe, where we must take into account the various circumstances

which influence the salubrity or otherwise of a district. Persons inhabiting large towns are liable to many factors which act towards deterioration, and there the death-rate is far higher than it is in country districts. If we compare the death-rates of the various capitals of Europe, we find that marked differences obtain; for instance, the death-rate in London is one-third less than that in St. Petersburg or Moscow.

It would add too greatly to the length of my paper were I to indicate all the facts known with regard to mortality in various European cities and countries. I would, therefore, only call attention to the certainty that, where sanitary precautions are properly carried out, the death-rate diminishes exceedingly; and, comparing those towns in the Tropics which are under the influence of European knowledge, we find that the average rate of mortality compares very favourably with that of towns in Europe where sanitary precautions are less attended to.

It is curious to notice that, when Europeans proceed to countries possessing a very different climate from their own, their children in a generation or two receive an indubitable impress from the climatological factors around them. Take, for instance, the Europeans who go to North America, and we find that they tend to approach in type to the original inhabitants of the soil. They outwardly resemble the North-West American Indians. The hair becomes straighter, coarser, darker; the cheek-bones become more prominent, and the rounded form of the face changes into the gaunt, lined face which is typical of the inhabitants of the United States. The skin takes on a sallow complexion, the voice itself changes, and the nasal twang, so apparent to Englishmen, becomes pronounced. Again, if we look at the residents in Australia, we find very peculiar results are induced there. Supposing, for instance, that a woman proceeds to Australia, having already given birth to three or four children, the children she subsequently gives birth to in the new climate do not resemble her previous progeny so much as they do the Australian type.

Further, granted that the Anglo-Saxon race can maintain itself, and become acclimatised, as in Australia, New Zealand, and America, is it not probable that the race may undergo such changes as materially to alter those qualities upon which the worth of the race, so-to-say, depends? Are not the *Cornstalks* of Australia, the Anglo-New-Zealanders, etc., practically different from their ancestors, and do not they severally indicate a tendency to change to an altogether new type of manhood with new aptitudes and capabilities? But this very interesting question cannot be further discussed.

We have also to consider what effect the liability or otherwise to disease has with reference to the possibility of acclimatisation. (a) A lengthened residence gives strangers a certain immunity from such diseases as dyspepsia, and all that wide class of disease which is induced by plethora. It may be, too, although the fact is denied by some authorities, that the longer a European resides in some portions of the Tropics where yellow fever obtains, the less likely is he to suffer from that fever. (b) The probability of strangers suffering from certain diseases is heightened by the length of residence. For instance, a person is far more

likely to suffer from malarial fever, and all those chains of symptoms induced by malarial intoxication, the longer he resides in a district where malaria is rife. In this connection, it must be noted that, although a person himself may be obnoxious to the influence of malaria, yet it is indisputably proved that his children will be susceptible in a very marked degree to the debilitating influence which malaria exerts upon the organism. (c) We must also not lose sight of the fact that there are certain diseases which strangers are only likely to suffer from after a prolonged residence in the Tropics. This depends more or less upon the amount of cachexia affecting the individual, and such diseases as yaws or elephantiasis can only make their appearance in those who have resided for so long a time in the climate in which they are indigenous that certain climatological factors have so far impressed themselves upon the individual that a predisposition to the disease is induced. With regard to these diseases, there is reason to hope that within a very few years a method of prophylactic treatment may be evolved which will prevent their occurrence at all. Indeed, with regard to elephantiasis, the researches which I have been able to make seem to show that it is a preventible, and even curable, disease. (d) There are finally certain diseases which only occur in children of the second generation. They occur after dentition, and are of an atrophic character. Up to the present time nothing has been done to control these diseases, yet I am convinced that if during pregnancy the mothers were properly treated, and if during the early years of child-life proper prophylactic medication were attended to, much might be done to save such children from the effects of environment and to fortify them so that they might bid defiance to the climatological factors which till now have either rendered their existence in the Tropics impossible, or have induced such a state of constitutional debility as to necessitate a return to Europe in order that they should survive or be prevented from becoming sterile.

Looking at the factor of heat, we have to think whether it is a high mean annual temperature or only a high temperature without any seasonal variation; because for Europeans, if we have a climate where the seasonal variation is 30° F., or over, we find that the people can do as well if not better than in Europe. In those places, however, where there is only a mean annual variation of 10° or 15° F., or where the diurnal variation is less than 10° F., immigrants cannot stand the climate. It is curious, no doubt, to speak of cold when dealing with acclimatisation of Europeans in the Tropics; but cold exerts a great influence on the capability of withstanding a Tropical climate. We find that in regions where, the mean annual temperature being equal, the diurnal variation is excessive, individuals from Europe cannot withstand this fluctuation; because, granted that a person is ready to perspire with the hot daily temperature, he cannot withstand the cold nightly variation which so often obtains.

With regard to endemic diseases, altitude undoubtedly plays a definite rôle: malaria, for instance, is far less virulent when we attain an altitude of about 3000 feet; and with regard to yellow fever, we know

that, at an altitude of over 1000 feet, it can never exert epidemic virulence.

Summing up what we know respecting the heat, the cold, and the diurnal variation of temperature in the Tropics, we come to the conclusion that it is impossible for any European nation to become acclimatised *at once* in any Tropical region; but we think that if the attempt be made step by step, generation by generation, it is not improbable that northern Europeans may become acclimatised in, say, 100 years, in Tropical India or Africa; and that if representatives of a nation were to endeavour to proceed gradually from a Temperate to a Tropical country, they might, in five or six generations, acclimatise themselves either to the north or to the south within 30 degrees of their original habitat.

In conclusion, it must be admitted that the permanent residence of Europeans in Tropical climates must be first attempted in those regions possessing a definite altitude—an altitude which will give them considerably less heat, less moisture, and a greater immunity from endemic diseases than low-lying plains.

AMONG THE MACHINGA PEOPLE.

BY R. S. HYNDE.

DOMASI, one of the stations of the Established Church of Scotland Mission, in British Central Africa, lies on the northern slope of Mount Zomba, having on the west Mount Malosa (usually represented as forming one mountain with Mount Zomba), and with Lake Chirwa (Shirwa) about fourteen miles to the east. Its exact latitude is $15^{\circ} 18' 4''$ S., and its longitude $35^{\circ} 18' 7''$ E.

The station being, as I have said, situated on the northern slope of Zomba, with Malosa on the west, while a spur of Malosa looks down on it from the north, and having two small hills on the north-east, lies at the south end of a small valley. It takes its name from the river Domasi, which flows past it at a distance of about half a mile to the north-east. The Domasi is a mountain stream which takes its rise from two feeders, one on Malosa, the other on Zomba, and flows down the valley between the two mountains, cutting its way between the spur of Malosa and one of the small hills already mentioned. After a tortuous course it eventually discharges itself into Lake Chirwa. During the first half of its course it has a very steep gradient and a rocky bed, over which it flows with great rapidity. It falls very low in the dry season, but rises considerably in the wet season: hence the difficulty of bridging it. This rapid rise and fall is characteristic of all the streams of the Shiré Highlands.

Mount Zomba, as is well known, is about 7000 feet high, and Malosa is of equal height. There is nothing remarkable about either mountain unless it be the warm spring on the eastern side of Malosa, in which, however, the water is small in volume and of low temperature, and has no peculiar taste. Very different are the Morambala springs, which I