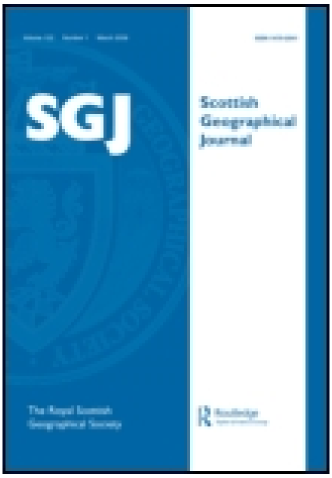

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Gold and silver mining and reduction processes as responses to geographic conditions

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volume to itself to do it justice. At present all that we are concerned with is the general denudation of the region.

When it is recognised that the existing mountains represent only a fourth or a fifth part of the original land mass, it needs but little imagination to conceive of a time when the entire region must be reduced to its base-level. Should no renewed crustal compression supervene, all that vast array of stupendous heights must gradually crumble down, and be ultimately replaced by a gently undulating plain. The process of decay, everywhere conspicuous, will go on apace until, with the gradual lowering of the surface, the rate of waste will diminish, but nevertheless degradation will never cease. The rivers and their multitudinous affluents must continue to deepen and widen their valleys, and to cut back into their watersheds, and thus the mountain-ridges that separate the valleys will gradually lose in height and width. All the beautiful lakes will disappear at an early stage. At present they form the base-levels of the drainage-areas in which they lie—they are the receptacles of the waste-materials of the mountains, and must be relatively soon silted up. Thereafter the detritus of the Alps will make its way by the great rivers to the sea, which will then have become the base-level. Slowly but surely the plain-tracks of rivers and streams will travel up the valleys—slowly but surely the heights of the land must be reduced, until the entire Alpine area is finally resolved into a rolling plain. The cycle of erosion will then be completed.

But the geological history of other mountains, and of the Alps themselves, teaches us that a cycle of erosion may be interrupted by crustal movement. The present Alps, it will be remembered, were preceded in Palæozoic times by an extensive mountain-land, which after a prolonged period of denudation sank in the sea, before it had been completely reduced, and remained submerged during the course of long ages. In other cases a mountain tract, after experiencing much erosion, has again been uplifted, and its final demolition has thus been deferred. But with renewed upheaval denudation proceeds more rapidly, for the rivers with their increased gradients regain their former greater activity, and if the uplift has been considerable the action of ice may be added to that of running water. The lowering of the land continues, and will not cease, even should occasional uplifts recur, until the region is either submerged or worn down to its base-level.

GOLD AND SILVER MINING AND REDUCTION PROCESSES AS RESPONSES TO GEOGRAPHIC CONDITIONS.[1]

By George D. Hubbard, Oberlin College, Oberlin, Ohio, U.S.A.

Gold and silver receive different methods of treatment varying with their occurrence and association. All through the story of their mining

[1] This paper is a portion of a thesis presented as a part of the requirement for the Ph.D. degree in Geography at Cornell University. See this *Magazine*, 1910, pp. 449-466; *Bull. Amer. Geog. Soc.* 1910, pp. 594-602, and a later number; and *Bull. Geog. Soc. Phil.* 1911, pp. 1-22, for other parts. Special thanks are given to Professors R. S. Tarr, W. F. Willcox, and H. Ries of Cornell for criticism and suggestion throughout the whole work.

in the West, the responses and adaptations to conditions have brought changes in methods of mining and handling, and have developed mechanical and technical skill and inventive genius.

Gold.

Placers.—In most localities in the Western U.S.A. and Alaska, this metal was first discovered in gravels and sands in or near stream-beds whither the streams had carried it from nearer their head-waters. There they found it in fragments formed by the disintegration of country rock containing gold in veins and ore bodies. As the rock was carried down stream it was sorted, and much of the lighter and more destructible fragments was swept entirely away, while what remained contained most of the gold. The waste left along the stream-bed was made up of rounded gravel, sand, and the fine pieces of gold, and was deposited more or less uniformly. Such auriferous deposits are called placers, and were very rich in the gulches of the Sierras and common all through the mountains. Because of the ease of detecting the metal in them they were the first forms of gold to attract attention. The process of sorting out barren rock-waste and concentrating the gold in a much smaller quantity of earth has been of inestimable value to man. He takes up the work where Nature left off, and by further concentration eliminates all but the gold.

The simplest and cheapest method of mining placer gold is that of washing the auriferous gravels in a pan or even with a shovel or in a short sluice, with water to remove the rock fragments and thus to separate the gold, which, by virtue of its greater specific gravity, remains in the pan or behind cleats on the bottom of the sluice. This method was used because it was simple and effective in the rich, unconsolidated placers, and because its apparatus was at hand or quickly made. Time in those days was gold. Its use continued because it was so effective in the high-grade gravels, and because complicated apparatus was not obtainable and was no more effective. Apparatus that would get the most gold in the shortest time and in the easiest way was the kind used. Bancroft[1] explains that these methods continued in California because the abundance and richness of the deposits lasted, and because miners were relatively few. The same law has held in many placer deposits outside of that State. Owing to these factors, when the amount of gold obtained in one gulch became too small, it was cheapest to move to a new, unoccupied one and continue the use of the simple machine. But because the continuous influx of men, attracted by the gold and the opportunities that gold-mining presented, so increased the competition; and because the crude but rapid mining so soon compassed the richest beds, less remunerative gravels had to be worked, and improved methods devised to recover more perfectly, and at a single washing, the valuable contents of the earth. The above simple processes, used at first, required little or no

[1] Bancroft, H. H., *Hist. of Calif.*, vol. vi. p. 409.

co-operation, and hence tended to develop independence of work and thought.

The less remunerative gravels were simply bars, or deserted stream-beds, which, owing to less favourable conditions for deposition, contained a lower percentage of gold; or else they were deeper down and required more labour and expense for the same return. Under the impulse of these new conditions, and in order to cheapen the process, a long sluice with more cleats to catch the gold, called a long-tom, also a hand rocker similar to an old-fashioned child's cradle with cleats across the bottom, were used. These machines, called for by the poorer gravels, required two to four men to work in a squad, but made it possible for them to produce about the same values as if working each for himself in better gravels. Royce[1] shows that the long-tom or long sluice mining meant increased responsibilities of many sorts, and so in the end made for good order. It also had a part in developing that social compact whose factors were called "pards," because of their partnership work with the machine. Then as the business was extended, longer board sluices, and finally, because the boards wore out too fast, long rock-floored ditches came into use, requiring a larger squad, and hence demanding a larger company of profit-sharers or the employment of wage-earners.

More water was needed with these larger machines used in working lower-grade gravels. When it was near, little expense arose even in the use of the more improved methods; but if the water-supply was insufficient or not permanent, capital and more costly works were necessary. In the first place, ditches or flumes were made to lead the water from external sources to points where it was needed. In the second, as much as possible had to be made of the water that was near, and it had to be so used that it could not destroy the works after storms. This co-operation and the more permanent nature of the plant for water conveyance, gave more permanence to camps, just as have river-bed mining and hydraulicking in other places.[2]

From the washing of the sand in marginal sand-bars to that of the gravel of the stream-bed was only a step. In order to reach the latter, the water had to be crowded off by a wing dam and a portion of the bed exposed. Then to get the entire river bottom the whole stream was diverted, and, to avoid the expense of dam construction, dredging with simple machines was introduced from New Zealand, where it had originated[3] and found rather general use. The dredging machinery, placed on a boat, raised the gravels from the bottom, washed them, recovering the gold, and returned them either to the water or to the land in the rear of the machine. A dredge boat was often launched in the water in an artificial pool made by excavating a hole in the bed of river alluvium, and the boat and pool advanced by digging gravel out in front and piling it in behind the machine.

[1] Royce, Josiah, *California*; in *Amer. Commonwealth Series*, 1886, p. 310.

[2] Royce, *loc. cit.*, p. 312.

[3] *Twelfth Census* (1900), *Mines and Quarries: Gold and Silver*, p. 573.

Owing to ease of handling the gravel, this method was capable of working deposits of very low grade.

Back from the stream, and usually a little above, occurred the bench gravels; and when these were found to contain ore, specially adapted methods arose to win it from them. Water was led out of the stream above the benches by a wing dam and conducted to the place in a ditch with less fall than had the stream. Then the washing began in rockers and long-toms. The workmen soon learned where to find the richest streaks in these benches or terraces and finally tunnelled for them. In Alaska, where the benches are sometimes of glacial origin, the richest streaks are differently distributed,[1] and required different treatment. Owing to climatic conditions, the gravels here are frozen most of the year, and must be thawed to be washed. At first they were thawed by building fires on them, but now this is usually done by driving pipes into them and then forcing in steam. Shafts and horizontal tunnels along rich leads are thus made.[2] Because these deposits are in a land of continuous frost, tunnels need no timbering, and shafts no pumps.

From stream gravels to beach sands was a short step, and in California many devices for working the latter have been tried and left to decay.[3] The difficulties are lack of fall for sluices, and, sometimes, lack of water. In California the Oregon tom, a short sluice, has been adopted. At Nome lack of fall declared against all sluices, and the surf against dredging. Rockers were used almost exclusively.

Still another set of conditions, the deposits of arid lands, has given rise to the process known as dry-washing or dry-blowing. In New Mexico[4] many unsuccessful attempts to utilise the wind have been made; and now a screen set obliquely and ribbed with riffles is supplied with placer material, and air is blown through the screen from behind to remove fine dirt. Coarse material is swept off with the hand, while the gold collects above the riffles. Owing to the absence of water for ordinary washing, many varieties of dry-blowing have been used in Southern California,[5] Northern Mexico,[6] and in Australia,[7] some of which were borrowed from the natives and some devised by the foreign miners; but all that were successful were adjusted to the highly specialised conditions of no water, dry dirt, suitable winds, and cheap labour.

All the above processes were used because of a special mode of occurrence of the gold—in loose, easily worked placers—and were of service only in such deposits. All were adapted to the special conditions

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1 Kemp, J. F., *Ore Deposits*, 1900, p. 393. *U.S.G.S. Professional Paper* 15, pp. 52, 54; *Mines and Minerals*, 1900, p. 492.

2 *U.S.G.S. Bull.* 225, 52-53.

3 *Scientific American Supplement*, 1900, p. 20,381.

4 *Mines and Minerals*, 1899, pp. 397-8.

5 Bowie, A. J., *Hydraulic Mining in California*, p. 79.

6 *Eng. and Min. Journ.* (1897), vol. lxiii. pp. 257-8.

7 *Am. Inst. Min. Eng. Trans.* 1898, vol. xxviii. p. 490 f.; also *Eng. and Min. Journ.* vol. lxv. (1899), p. 37.

in which the gold was found. Some had been used, in principle at least, in the foreign countries from whence many of the miners had come; but their introduction and improvement in the West was a direct response to the influence of the geographic conditions in which the gold occurred, and under which the men were obliged to work.

Amalgamation.—A modification of several of the above methods greatly raised their efficiency. Mercury had been discovered in California five years prior to the gold discoveries,[1] so that its use was possible as soon as conditions made it necessary; and now small quantities were put behind the riffles in the sluices to form an amalgam with the gold and thus recover many minute fragments formerly lost. Amalgamation processes had been used in Potosi, South America, near where mercury was mined, since 1571; also to some extent in Mexico, although the long distance to its source, Huancavelica or Spain, was almost prohibitive. By taking advantage of the presence of mercury, an advantage due to the geographic distribution of mercury, the South American miners and, later, those of California greatly increased their output and cheapened their processes. In the absence of mercury Mexico must have mined in the old wasteful way or have paid heavily for imported mercury.

Hydraulicking.—Men continued to come into the gulches and valleys, and the gravels and sands were becoming exhausted; hence prospectors and miners pushed farther up the streams to find new or better deposits, and, in 1851, discovered the fossil stream-beds high up on table mountains. The gravels and sands of these beds were stream-laid ages ago, and then overlaid with lava. Subsequent erosion had cut these deposits—lava, gravel, and sand—in two and removed a part of the gold-bearing beds, and after sorting and rewashing the gravels, and concentrating the gold, transferred them to the present valley floors. The remaining portions were rich and extensive, but could not be worked in the ordinary ways. The lava cover prevented beginning at the top. Most of the gold was at the bottom of the channels, and to get it required either moving the entire filling, or the construction of tunnels and the removal of the pay gravel. Tunnelling was expensive because continuous timbering was necessary. Then no water was near for washing. To develop these supplies of gold required capital and labour, and here began the first extensive systematic hired mining.[2] An adaptation of the long-tom sluicing with men shovelling gravel into the feed boxes was the initial device. In 1852, a man desirous of economising labour made a raw-hide hose and with water under head washed gravel into his sluice. His neighbours followed, and then improved by using first canvas hose, stove pipe, sheet-iron, and then heavy wrought-iron flumes, thirty inches in diameter and furnished with an elaborate nozzle. Some of these flumes were thousands of feet long,[3] and being connected with ditches or tunnels 10-100 miles long,[4] led water in large quantities from some higher level, often from beyond a divide, down to the partially cemented gravels with such

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1 Hubbard, G. D., *Bull. Geog. Soc. Phil.* (1911), vol. ix. p. 7.

2 Bowie, A. J., *Hydraulic Mining in California* (1885), p. 48.

3 Bowie, A. J., *loc. cit.* p. 49 f. 4 Eissler, Manuel, *Metallurgy of Gold* (1900), p. 51.

force as to tear them down and break them to pieces and then wash them into long sluices. Here their gold contents were sorted and caught in mercury behind the riffles. Sometimes the gravel was so firmly cemented that dynamite was exploded to aid the water in breaking it down. This new, elaborate process, called hydraulicking, could not be used successfully in other kinds of deposits, but was ultimately closely adapted to the requirements of these ancient gravels. Thus the cost of handling the gravel was reduced from dollars per cubic yard in the rockers of 1848 and 1849, first to $.35 in the long sluices, and then to half a cent in the hydraulicking process. Those who had resisted the temptation to spend all as fast as it was acquired usually became the capitalists in this new form of co-operation, while those who had wasted all, or who had been the victims of hard luck, became the labourers or withdrew to other occupations.[1]

Placers of Sierras and Rockies Contrasted.—Much the larger proportion of the placer-mining in the West per unit area has been in California. The Cretaceous rocks of the Sierras with their ledges of free milling ores, disintegrated into good placers with gold of a high degree of purity; but the propylitic rocks of the Rockies with their complex associations have not furnished so much placer gold nor such good quality as that in California. This geographic distribution of placers and their parent rock has had a beneficent influence on the development of the mining industry of the West. The native gold or gold in simple associations was found first, and where it could be easily worked, hence the industry flourished from the start. Had the two kinds of bed-rock deposits exchanged places, it would not have been so easy to find the first placers; and if the Eastern placers had been found first, they would hardly have been able to furnish capital for the later development of veins and lodes. And had the Sierra kind occurred in Western Colorado and Idaho, many of the hardships incident to reaching and developing the region would have been increased. Neither men nor provisions could have reached the place by sea. The long land journey from the East would remain, although much shortened, but there would have been added to the sea route a long difficult land route, from the coast far inland.

Vein Mining.—As gravels became exhausted, prospectors, followed by miners, pushed on up the ravines and discovered the quartz veins from which the gravel had come; and then there arose a different kind of mining. In these auriferous ledges as found in most of the Western States and even in the Southern Appalachians, the gold was intimately associated with other minerals, and the whole mass had to be broken out of the country rock and crushed before the precious metal could really be claimed. This required time, expensive machinery, mechanical skill, and withal a deal of adjustment to the conditions in order to operate the mines successfully. But, as shown above, capital was not wanting, and experiments began. By a normal process of selection a method of mining and reduction was perfected, but not until many fortunes had become exhausted and companies dissolved. Beside the exhaustion of the richer

[1] Bancroft, H. H., *Hist. of Calif.*, vol. vi. pp. 416, 418.

placers, another factor aided in the development of the quartz-mining. Hydraulic mining, discussed above, had been entered into by multitudes. By 1858, in California alone, six thousand miles of water-ditches had been built. About this time the waste from hydraulicking began to interfere with agricultural interests, and by 1884 the interference had advanced to such an extent that prohibitive legislation checked its further operations,[1] and capital and enthusiasm turned to quartz-mining, thus still more increasing the latter form which had now become well developed.

In the early days of quartz-mining the ore was crushed by stamps or rollers, and the rock flour washed as in the placer works. This process in its most perfect state did not save all the gold, so others were devised to meet the difficult combinations presented by the ores. A method known as the chlorination process has now come to be used extensively. The crushed ore before or after concentration, and sometimes after roasting, is treated with chlorine gas, which forms chloride of gold, soluble in water and removed by washing. From this solution the gold is easily recovered by precipitation with iron sulphate. Stamp mills customarily accompany chlorination plants, and smelting works are sometimes associated to handle special ores. This process is especially adapted to rather high-grade ores and those practically free from iron. A second chemical method probably more used than the above is known as the cyanide process, and is most serviceable in the treatment of low-grade ores. It finds its special field in the reduction of ore carrying iron and copper sulphides. The crushed ore in a "slime" condition is treated with a strong solution of potassium cyanide, usually strongly aerated, and the gold is thus brought into solution and separated from its refractory native compounds. Furnaces often follow the cyanide tanks, where with suitable fluxes the reduction to metallic gold of specially rebellious ores, by means of chemical reactions requiring heat, is effected. Had the ore occurred in small or more scattered deposits, even these processes would probably fail to extract the metal economically; but since large quantities of ore, even though of low grade, can be obtained within a limited area and be treated simultaneously, the expensive plant with its trained men, technical skill, valuable apparatus, altogether a costly equipment, can be operated at a profit. Illustrations of the failure of extensive plants to remain in operation are common; and usually they go out of business because the deposits are not as large as supposed, or because their contents are found to change character in the course of development, or because some resource, water, fuel or timber, has failed.

As already shown, the geographic conditions favoured the great development of placer-mining in the early days and called for little development of bed-rock ores. Table I. shows that there has occurred a great change since 1880 in the relative importance of quartz and gravel as sources of gold. In the early days of California and of most of the other States and Territories, including the Carolinas, Georgia, and even Alaska, a very large percentage of the metal came from gravels. No

[1] Hubbard, G. D., *Bull. Geog. Soc. Phil.*, vol. ix. (1911), pp. 14-15.

reliable statistics on this point dating back farther than 1880 have been found. In 1905 only 17 per cent. of the total gold production came from gravel. Alaska, the youngest gold producer, supplied over one-half of that amount, and she is also the only one with more than a handful in its total production that recovered more metal from gravel than from quartz. Owing to increased Alaskan placer-mining during 1906 and 1907 the total percentage of placer gold has gone up during these two years. Alaska is still in the placer stage of her gold-mining. If this territory with its relatively large placer production be taken out of the figures in Table I., the change in the source of gold will become much more apparent. This change occurred partly because the placers were insufficient to employ the men who had been attracted by them, partly because the placers were becoming exhausted, and there was no other mining but quartz to which the men might turn. The wealth accumulated from the early forms of mining was ready to go into the more expensive and complex processes, and the conditions required it.

TABLE I.—DISTRIBUTION OF GOLD AND SILVER AS TO SOURCES OF PRODUCTION.

Year.	GOLD (Fine Ounces).		SILVER (Fine Ounces).		
	Quartz.	Placer.	Quartz Ores.	Lead Ores (*b*).	Copper Ores.
1907	3,034,609	1,192,890	19,038,042	19,038,449	14,200,348
1906	3,374,639	1,328,361	16,792,799	21,011,464	19,288,709
1905	3,568,724	697,018	13,990,008	25,147,252	16,964,340
1904	3,245,097	647,383	15,113,401	26,973,843	15,595,556
1903	3,062,762	591,219	16,835,528	25,682,882	13,844,232
1902	3,315,717	597,964	16,988,647	28,035,620	12,812,291
1901	3,243,248	609,974	16,064,208	27,018,344	14,790,934
1900	3,269,794	597,850	16,496,711	30,593,763	13,121,912
1899	3,062,286	450,958	15,861,230	29,000,609	11,859,334
1898	2,812,579	372,215	13,716,882	31,312,676	10,457,275
1897	2,525,387	390,858	12,233,429 (*c*)	32,244,341	11,637,395
1893	...	...	27,641,100 (*c*)	24,713,100	7,645,800
1880[1]	1,741,654	580,478 (*a*)	...	...	...

(*a*) Excluding Alaska with 288 ounces.

(*b*) Colorado lead and copper ores, amounting to about one-half of this item each year, are not divided but are placed under lead together.

(*c*) Quartz and free milling ores combined.

Methods that are used with some kinds of ore are worthless in the treatment of others, and processes profitable under certain conditions would cease to be remunerative under others. In each locality a method of extraction and reduction capable of handling the ore in its mineral associations, and also adapted to the conditions of water, fuel, and transportation, must be devised. Because of the relation of mining and

[1] *Twelfth Census* (1900), *Mines and Quarries : Gold and Silver*, p. 547.

reduction processes to the vicinal geographic conditions, the latter may seem in cases to control the output; and so they do. But herein occurs an excellent measure of the influence of the metals. They are sometimes able to combat and overcome very gigantic obstacles. Many shaft and tunnel mines in California successfully met the conditions, because in the midst of timber. Had they with the same gold values been located in places where timber is so scarce as around some working surface mines in Arizona, New Mexico, or Nevada, the output of the mines could not have borne the expense because of their moderate values. But many mines in these more arid, forestless States are so rich that they can sustain the long timber hauls, the struggle (and often great expense) to obtain water, the difficulties of costly transportation, or the flooding of the mines with water, and have prospered for years against the heavy odds. The almost fabulous wealth or other special advantage of certain districts has enabled them to surmount the greatest obstacles and to produce enormous quantities of the precious metals. The Comstock[1] lode mines suffered because of excessive heat and of flooding with underground water, as well as through being in a desert with nothing near that was needed.

The Treadwell[2] mines on Douglas Island, Alaska, situated on a very low-grade ore body, in high latitude, and one thousand miles from Seattle, are able to run very satisfactorily because of abundance of water, sufficient water-power during the seven open months, plenty of fuel, cheap sea transportation, ore fairly uniform, constant as depth increases, abundant, and easily gotten out of the ground; and again easily reduced, because a large part of the values can be recovered by amalgamation. The average cost of operation here for nine years was $1.73 per ton, and the yield $2.18 per ton.[3] It is in the ability of these gold deposits to overcome such enormous difficulties that their influence is most clearly manifested.

Effects on Scenery.—The influence of some of the above processes on the surrounding features, landscape, forest, and stream, is very appreciable. Gulches once as beautiful as a picture have been dug over, washed out and refilled with débris, upon which vegetation has not yet obtained a footing. In many places desolation is the only word. Scarred hillsides and pillaged ravines are seen at almost every turn in extensive mining regions. Of course gold-mining is not very different from other mining in this respect, but the speed with which ends have been reached and destruction wrought will compare favourably with any other mining operation. The early California days, however,[4] did not witness damaged forests except where these were cut for building houses (rare structures at first), because timber was not needed to support tunnels and shafts so long as placer-mining continued; but later the axe worked havoc, gathering material to timber the shafts and tunnels in the quartz seams and to build mills, roads, and railroads. The same sequence may be

1 *U.S.G.S. Monog.* iv., pp. 56 f., 389 f.

2 *U.S.G.S. Bull.* 225, pp. 28, 42.

3 *Twelfth Census* (1900), *Mines and Quarries: Gold and Silver.*

4 Bancroft, H. H., *History of California*, vol. vi. p. 416.

noted in many places in other States. Where smelters producing noxious fumes are being used, their influence on the vegetation is appalling. It is stated [1] that there are no trees in Butte and Anaconda, Montana, although formerly there were plenty. Sulphurous acid gas is produced by roasting sulphide ores, and this gas is destructive to vegetation. It is also a disinfectant, killing disease germs. Through special efforts recently to check the nuisance, its destructiveness had been so reduced that a few small gardens and some house plants are now growing.[2]

(*To be continued.*)

THE VEDDAS.[3]

It is to Robert Knox [4] that we owe the first accurate description of the Vedda and his surroundings. Long before Knox's day strange stories had been told by Chinese and Arabian merchantmen of their intercourse with the genii and demons of Ceylon, who, when the season for traffic arrived, "appeared not but set out their precious commodities marked with the exact price; if these suited the merchants, they paid the price and took the goods." [5] There can be but little doubt that these early notices refer to the Veddas, who practised, if they do not now practise, this curious mode of trading. But it was Knox who was the first to supply in some detail trustworthy information in regard to this primitive people. His account has been amplified and supplemented by many later writers, and of these the most important are Bailey,[6] Nevill,[7] the Sarasins,[8] and the authors of the work under review.

There are three questions regarding the Veddas which are of special interest. Firstly, what were their characteristics when untouched by civilisation? Secondly, to what other races are they related? And, thirdly, what is their present condition? As regards the first question it may be said that Dr. and Mrs. Seligmann have set forth clearly and distinctly all that is known from early notices of the Vedda in a state of nature, and that, as regards the third question, they have made valuable additions to our knowledge of his present condition. With the second question they have hardly concerned themselves, and yet it is one which

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1 Correspondence with H. V. Winchell, April 1905.

2 Correspondence with W. H. Weed, March 1905.

3 *The Veddas*, by C. G. Seligmann, M.D., Lecturer in Ethnology in the University of London, and Brenda Z. Seligmann; with a chapter by C. E. Myers, M.D., D.Sc., and an appendix by A. Mendis Gunasekara, Mudeliar. Cambridge: At the University Press, 1911. Price 15s. net.

4 *An Historical Relation of the Island of Ceylon in the East Indies.* London, 1681.

5 *Pilgrimage of Fa Hian*, from the French edition of the Foe Koui Ki of Remusat, Klaproth, and Landresse (Calcutta, 1842), p. 332.

6 *An Account of the Wild Tribes of the Veddahs of Ceylon.* (Trans. of the Ethnological Society, New Series, London, 1862, ii.)

7 *The Taprobanian*, 1886, vol. i.

8 *Ergebnisse Naturwissenschaftlicher Forschungen auf Ceylon in d. Jahren* 1884-86. Wiesbaden, 1903.