

## OBSERVATIONS

ON

## THE EFFECTS OF CUCA, OR COCA, THE LEAVES OF ERYTHROXYLON COCA.

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THE brief notice taken in my introductory address to this Society in November last, of the restorative and preservative virtues of the Peruvian cuca or coca-leaf against bodily fatigue from severe exercise, has led to numberless references to me by friends and strangers in all parts of the kingdom for information as to its effects, its safety, its applicability to the treatment of some states of disease, and the quarters in which it may be obtained. As I am not aware of any trials of it having been made in this country, either earlier than mine or so extensive, and as I shall probably best answer the many inquiries sent me by publishing an account of these experiments, I have been induced to present the following narrative to the Botanical Society. The inquiry, of which my recent trials form a part, is very far from being complete, because my supply was quite inadequate till the other day, when I received a sufficiency through the kind services of my colleague Professor Wyville Thomson, of the *Challenger* expedition. But the facts already obtained will probably interest not a few at the present time, were it for no more than that they set at rest all doubts that the more important of the effects of cuca, experienced in its own country by the natives of Peru and the neighbouring states, may be equally produced in Europeans at home; and that, contrary to what seems universally believed in Peru, the virtues of the leaf may be preserved, with due care, for many years.

Since my observations must bear reference to what is the doctrine and practice of the Peruvians as to the use of this vegetable, I must introduce the subject with a summary of what has been written about it by the historians of Peru and by travellers in that country. The accounts which have thus appeared from time to time are apparently very contradictory; but I think they may be reconciled, and a consistent result obtained.†

In the first place, however, let me remark that I have ventured to restore to the commercial article its original name, cuca. This was its Indian name, which the Spaniards corrupted into coca. But there is no reason why other nations should adopt a Spanish corruption; and there is a very good argument against transferring it to our own tongue, inasmuch as we have already two totally different vegetable products, cocoa and cacao, which, as indiscriminately pronounced in ordinary speech, coco and coca, are indistinguishable from the corrupt name of this new invention. I hope, therefore, that others will second me in attaching a characteristic name to an article which seems very likely to come ere long into general use among our countrymen at home.

The early historians of Peru have taken special notice of the culture, properties, and uses of cuca. Among these, none is more full, clear, and fair, than the famous chronicler of the reign of the Yncas and of the Spanish conquest, Garcilasso de la Vega. His narrative bears internal evidence of great historical care. Other reasons, to be alluded to presently, also add to the confidence which the statements themselves create in the reader; and hence it is scarcely necessary to refer to any other early authority.‡ Garcilasso's information was derived partly from what he personally knew, partly from a Spanish priest, Blas Valera, who was long in Peru, and whose manuscripts came into the historian's possession.

G. de la Vega informs us that the use of cuca in Peru dates from an early period of the dominion of the Yncas; that at first it was scarce,

and was monopolised by the monarchs themselves; that it was employed as an offering to the sun, their parent and deity; and that sometimes, however, a basket of it was presented to one of their curacas, or lords, to whom the ruler desired to show special favour. But, as the Yncas extended their conquests northward along the Cordilleras of the Andes, the culture of the plant also became much more widely extended, through the acquisition of suitable lands for the purpose; the leaves came gradually into more general use; and at the time of the Spanish conquest of Peru, the natives almost universally indulged in cuca-chewing. The Spaniards, however, were too devoted Catholics to fall into a custom which was the offspring, and continued to have the savour, of profane heathen rites. The chewing of cuca was detested by them, condemned by public opinion, and charged with being baneful to the health of those who gave themselves up to it. Strong prejudices thus prevailed against it. But Garcilasso de la Vega and Blas Valera protest against these prejudices, and declare that the Peruvian natives esteemed cuca as above gold and silver in value; that it possessed great energy in preserving strength during fatiguing exercise and privation of food; that it was an useful medicine for improving the teeth, mending broken bones, curing maggoty sores, and warding off the effects of cold; and that another important purpose served by it was to enrich the Spanish traders in it, and to supply the chief tithes of the cathedral and canons of Cuzco.

The plant is described as a shrub about six feet high, much resembling in foliage the strawberry-tree of Spain (*Arbutus Unedo*), but producing much thinner leaves; and it is stated that the gatherers pick off the leaves individually with caution; dry them quickly in the sun, so as to retain their green colour, which is much prized; and preserve them carefully from damp, which seriously damages their quality. Garcilasso adds an anecdote which illustrates both the Spanish dislike and the real virtues of cuca. A Spanish friend of his met one of his countrymen, a poor soldier, plodding his solitary way among the Andes, chewing cuca, and carrying his two-year-old child in his arms. On upbraiding the man for adopting a barbarian custom, abhorred by all true believers as the fruit and symbol of idolatrous worship, the soldier said that might be; he at one time shared in these prejudices, but had found he could not carry his child without the strength which the cuca imparted, and was too poor to afford the cost of a bearer to relieve him of his burden. Nowhere does the author of the *Royal Commentaries of the Yncas* say one word of any evil consequences actually resulting from the use of this vegetable becoming a habit.

In face of the opposition it received from subsequent authors, and from some modern travellers, this testimony of Garcilasso de la Vega may be received with favour. He was son of one of Pizarro's conquering captains of the same name, by a niece of one of the last of the Yncas. He would, therefore, escape the tendency of the pure Spanish race to vilify the manners and customs of the people they had subdued; and his native and royal extraction gave him access to full information on such a subject. It is true that he left the land of his birth at the age of twenty (in 1550), and passed the remainder of a long life in Spain. But a youth of his family extraction on both sides was old enough to take part in the stirring events of the period while he remained at Cuzco; and, after leaving it for Spain, he kept up correspondence with the friends he left behind him, collecting from them information for his history.

I was first led to pay attention to the Peruvian custom of chewing cuca by reading, full forty years ago, the *Travels in Chilé, Peru, and on the River Amazons*, of the German naturalist Pöppig, who has taken a very different view of this national custom from Garcilasso de la Vega and Blas Valera.\* Pöppig was no less than five years in these regions, from 1827 to 1832, and passed much of his time among the cuca-chewers in the forest regions of the Peruvian Andes. Probably no European in the present century had such opportunities of intimately studying the habit. His statements of fact and his opinions are, therefore, entitled to much consideration.

The conclusion at which he arrived is, that the habit is as seductive and as injurious to health, mind, and morals as that of tipping in Europe, or opium-eating in the East. He says it is almost confined to natives of the aboriginal red race, has not been adopted by negroes, and is discountenanced among all of European descent; that even those who use it to no great excess must stop their work several times a-day to chew their quid contemplatively, and are much displeased if disturbed in their placid enjoyment; and that those who have got thus far are apt

\* Read to the Botanical Society of Edinburgh, on April 13th, 1876.

† After the following summary was completed from the original sources, I have found that some part of the subject has been similarly treated in a good article in the *Pharmaceutical Journal* for 1870-71, by M. Fournier.

‡ The *Royal Commentaries of the Yncas*. By the Ynca Garcilasso de la Vega. 1609-1617. Translation by Clements R. Markham, C.B. London, 1871.

\* Pöppig, *Reise durch Chilé, Peru, und auf dem Amazonenstrom*, 1827-32. Berlin, 1835. I am not aware that this interesting work has ever appeared in an English dress; but a translation of that part of it which relates to the culture and use of cuca may be seen in Hooker's *Companion to the Botanical Magazine*, 1835, ii, 161.

to become mere slaves to it, surrender every other occupation for it, and, quitting society, pass their time in the wild forests between hunting for their sustenance and lying under a tree chewing their beloved weed, calling up delightful visions and building castles in the air, and so insensible to outward occurrences as to remain thus all night indifferent to cold, torrents of rain, and even the howlings of the panther in their neighbourhood. But, in the end, the stomach gives way; the countenance becomes haggard, and the limbs emaciated; they can no longer take sufficient food, and even lose all relish for the enjoyment which has been insidiously destroying them; constipation sets in, even obstruction of the bowels ensues, or jaundice, or dropsy; and thus at last life is cut short about the age of fifty by one or other of these maladies, or through simple extenuation and exhaustion. Sometimes, when a fit of excess is followed by dislike, and the habit is suddenly abandoned, the sufferer rallies, and seems about to be reclaimed. But, ere long, like the drink-craver in exactly the same circumstances, he is driven by an uncontrollable impulse to further and worse indulgence. When the habit has thus degenerated into a vice, the victim becomes, in the language of the country, a coquero, and is irreclaimable. If a man of Spanish blood begin to use cuca, he is at once looked on with suspicion; for usually, in the course of time, he abandons himself entirely to it, and becomes an outcast from the society in which he moved. Pöppig gives, among other instances, a melancholy tale of a young man of good station in Huanuco, who fell into this vice, lived for some time the life of a savage in the woods, was found out by his relatives in a miserable condition in a remote native village, and was brought back to town by force, and for a short time apparently reclaimed. But at length, eluding his friends, he fled back again to the mountains, and resumed the habits of a confirmed coquero.

It is unnecessary to follow Pöppig further through the arguments and illustrations, very interesting however, by which he was led to denounce cuca as a deceitful and destructive stimulant of the narcotic kind. He allows, nevertheless, that it has really wonderful power in supporting the strength under prolonged fatigue without food. He mentions that, in his long rides through the Peruvian forests, he had seen his Indian followers accompany him on foot for fifty miles in one day, without food, or anything else except cuca; and that, in the revolutionary wars which ended with the Spanish American States throwing off subjection to old Spain, the native Peruvian troops, poorly clothed and ill fed, were able to fall upon their enemies by surprise, by making long marches among the mountains without food or sleep, merely resting for intervals of a few minutes occasionally to refresh themselves by cuca-chewing. He adds an important fact, which I am able to confirm, that, when his day's journey came to an end, he did not find his Indian attendants had at all lost their appetites; for, when done with work for the day, although they did not care for food while travelling and chewing, they made an excellent meal in the evening, usually eating twice as much as satisfied his own hunger. These last rather inviting statements will prepare the way for the more favourable testimony of ulterior travellers on the same subject.

Three very able observers, who have since spent some time as naturalists in Peru and became familiar with the fondness of the natives for the cuca-leaf, have treated the question minutely; and they separately bear witness to the soundness of the views of Garcilasso de la Vega and Blas Valera, and to some mistake on the part of Pöppig, for which it is not easy to account. It is important to see to what their testimony exactly amounts. It is by no means sufficient, as some have thought, to set aside Pöppig's statements, by referring to the wide dissemination of the Peruvian habit. It has been said, indeed, to be nearly universal among a population of eight millions inhabiting the Andes; and the annual collection of the leaf has been estimated at no less than thirty millions of pounds. But the habit of intoxication with opium, or with alcoholic spirits, might be upheld on the very same plea.

In 1838, Dr. von Tschudi visited Peru, and was for some time in the neighbourhood of Lima, as well as in various other districts, where the natives of Indian race almost universally use cuca, and where he himself repeatedly made trial of it.\*

Dr. Weddell of Poitiers, who had previously investigated with singular success in Upper Peru the botany of the cinchonas, and was the first to discover there the true yellow bark tree, the most valuable of them all, revisited Bolivia in 1851, where, in the province of Yungas, the finest cuca is said to be cultivated. He, too, made trial of it himself, and had very ample opportunities of witnessing its use and its effects among the Peruvians.†

In 1860, Mr. Clements Markham, who had charge of the Govern-

ment expeditions to Peru in quest of cinchona plants for cultivation in India, was much in the wildest forest districts of Lower Peru, immediately adjoining Bolivia, was always attended by cuca-chewing natives, and not unfrequently followed their example.\*

All these authorities, undeniably of the first rank, agree that the repulsive accounts of Pöppig are much exaggerated. The general result of their experience is to raise a suspicion that, in a few instances, his deplorable history of the abandoned irreclaimable coquero may be not far from the truth. But they do not seem to have themselves met with any such cases. Von Tschudi, indeed, says, that a profligate coquero may be known by his foul breath, stumpy teeth, pale quivering lips, black-cornered mouth, dim eyes, yellow skin, unsteady gait, and general apathy; but in his narrative, obviously in part compiled, he does not say he described such a man from actual observation; on the contrary, all three travellers represent in colours more or less strong the great utility of cuca to the Indians in the hard labour they have to undergo.

Von Tschudi observes that, in his own trials, he found it to be a preventive of that difficulty in breathing which is felt in the rapid ascent of the Andes; that, when frequenting the Peruvian Puna, or great desert table-land, 14,000 feet above the level of the sea, a decoction of the leaves enabled him to climb heights, and pursue swift-footed game, with no greater difficulty than in similar rapid exercise on the coast; and that he experienced a sense of satiety which did not leave him till the time of the next meal after that which he ought otherwise to have taken. He mentions the following instance, which he carefully watched, of the power of the Indians to bear long fatigue without any other sustenance. A miner, sixty-two years old, worked for him at laborious digging five days and nights without food, or more than two hours of sleep nightly, his only support being half an ounce of cuca leaves every three hours. The man then accompanied him on foot during a ride of sixty miles in two days; and, at parting, expressed himself ready to engage to undertake as much as he had performed. Nevertheless, von Tschudi was assured by the priest of the district that he had never known the man to be ill.

In general terms, this traveller declares he is "clearly of opinion that the moderate use of cuca not only is innocuous, but may even be conducive to health"; and, again he observes, "after long and attentive observation, I am convinced that its use in moderation is nowise detrimental, and that without it the poorly fed Peruvian Indian would be incapable of going through his usual labour. The cuca plant must be considered a great blessing to Peru".

Weddell, in less glowing terms, says, that careful inquiry where cuca is most in use satisfied him that it might be injurious to Europeans not gradually accustomed to it; but that it has the power of sustaining the strength for a time without food, yet without interfering with the appetite soon afterwards; that, in his own trials, he experienced a slight excitement and a little subsequent sleeplessness, but nothing else; and that, in the countries he visited, he never saw things go the length described by Pöppig, who must have been misled by exceptional cases.

The testimony of Clements Markham is very explicit. He says the properties of cuca are to enable a greater amount of fatigue to be borne with less nourishment and to prevent difficult breathing in the ascent of steep mountain-sides; that, although when used to excess it is prejudicial to the health, yet "of all the narcotics used by man, it is the least injurious and most soothing and invigorating"; that he chewed it frequently, and, besides an agreeable soothing feeling, found he could endure long abstinence from food with less inconvenience than he could otherwise have felt; and that it enabled him to ascend precipitous mountain-sides with a feeling of lightness and elasticity, and without losing breath. "It enabled him to ascend the mighty passes of the Andes with ease and comfort."

It is difficult to reconcile with these favourable opinions the very opposite conclusions of Pöppig, founded apparently on personal observation. Probably, he was too prepossessed with the abhorrence with which the practice of chewing cuca was regarded by the white inhabitants of the towns; hence he might have mistaken for the effects of the habit what perhaps was no more than the physical expression of the natural indolence of the Indian race when indulged in to excess; or, in other cases, the result of over-indulgence in ardent spirits, which, he says, the coquero sometimes adds to his other vices.

Mr. Bates met with this habit among the natives on the banks of the river Amazons, where he says it is regarded with abhorrence by respectable people, and therefore only practised secretly. He represents cuca, there called ypaau, as stimulating and not injurious when used in moderation, but producing weakness and nervous exhaustion

\* *Travels in Peru, etc., during 1838-42.* By Dr. T. I. von Tschudi. Translation by Thomasina Ross. London, 1847.

† *Voyage dans le Nord de la Bolivie, etc.* Par H. A. Weddell. Paris, 1853.

\* *Travels in Peru and India.* By Clements R. Markham. London, 1862.

when indulged in to excess. His observations, however, are too brief and general to throw much light on the subject.\*

The shrub which produces *cuca* thrives best in the clearances in the elevated forests of the Andes, in a climate distinguished by frequent rain-showers, and exemption equally from frosts and from extreme heats. In due season it is covered with clusters (fascicles) of delicate white flowers, which give it the appearance of our blackthorn in spring; and the flowers are succeeded by red berries.† The plants bear stripping of their leaves three times in the course of the year. Great care is usually taken to nip them off without hurting the axillary buds. They are dried at once quickly and thoroughly, and so as not to curl; at least, all good specimens I have seen present the leaves flattened and many of them entire, almost as if intended as a herbarium. Great care is taken to keep them afterwards dry, when transported from place to place. When newly dried, they have a strong odour, which is said to be apt to cause headache in those who frequent the drying-floors for the first time; but this odour passes off by the time the leaves are packed. The packages when opened have a powerful tea-like odour; which they retain on reaching Europe, if duly protected from damp. In Peru it is alleged that their properties soon deteriorate, that in a few months they lose much of their virtue, and that when taken to the coast they are worthless in twelve months. This statement, however, must be received with some limitation. It is evident, from the pains taken in Peru to preserve them from damp and exposure, that the leaves are easily damaged without due precaution; so that neglect will account for the inferiority of many old samples. Besides, it is contrary to all analogy, that leaves destitute of volatile oil, at least not owing their virtue to volatile oil, should lose them under careful preservation from the ordinary causes of decay; and various medicinal leaves of European growth, formerly thought to become inert by keeping, are now known to retain their properties very long, since we have been aware of the precautions for preserving them. Further, specimens brought to Europe have been found to yield a crystalline principle, which physiologically possesses no mean activity as a narcotic, which is probably the active ingredient, and which apparently bears transport and long keeping well. Lastly, well preserved *cuca* will produce in Europe in no small degree, after being kept several years, the remarkable effects on man which are every day experienced in Peru.

*Cuca* is not yet a regular commercial article in this country. In the prospect of its soon becoming so, the characters of a good sample should be well understood. I have had two fine specimens of it, and have seen several evidently much inferior. The fine qualities consist of leaves in a great measure unbroken, often folded, but many of them too spread out, never curled, but always flattened, never brown, always deep green on their upper and gray-green on their under source, and uniform in that respect, seldom mottled in colour. They are thin and crisp, beautifully reticulated, and traversed longitudinally by a single fine vein on each side of the strong midrib. In mass they have a strong odour resembling that of tea, and when chewed they have a peculiar well-marked herbaceous taste, not disagreeable, followed, after a continuous chewing for some minutes by a gentle, pleasant sense of warmth in the mouth. Inferior specimens, besides differing in appearance from these, have a fainter odour, and do not occasion warmth in the mouth when chewed.

*Cuca* has been subjected to chemical analysis, and found to contain a crystalline principle, to which naturally has been given the name of cocaine. But it is not my intention to enter here into the chemistry of the subject.

Nor is the Botanical Society the fit place for discussing fully the experimental investigations which have been made into the physiological actions of cocaine, or of *coca* itself, further than as they bear on what has been said above upon that point, or on what is to follow as the account of my own observations. In that respect, the most important inquiry is that of Dr. Mantegazza of Milan, published in a prize essay, which has been noticed in the *Oesterreichische Zeitschrift für Praktische Heilkunde* for November 1859. He found, by personal trials, that in small doses it promotes digestion, increases the frequency of the pulse, raises the animal heat, and accelerates respiration; that in a dose somewhat larger, there is added a facility of motion and desire for it, succeeded by a soothing effect; and that in a large dose, such as three drachms or upwards, it doubles the rate of the pulse, causes flashes of light, headache, strong tendency to muscular action, and great vigour of mind, succeeded by a state of pleasing, imaginative calm, described by him in brilliant colours, which resemble the poetical ravings of De Quincey, in representing the visionary musings of the opium-eater.

\* *The Naturalist on the Amazons*. By Henry W. Bates. London, 1863, ii, 211.

† A specimen of the plant is now in flower in the Edinburgh Botanic Garden (April 1876). It is well represented in an uncoloured engraving in Hooker's *Companion to the Botanical Magazine*, ii, 25, 1836.

Were these effects the general rule, there would be more justice in the unfavourable representations of Pöppig than has been hitherto admitted. It must be allowed as some confirmation of Mantegazza's statement, that Weddell thought he occasionally observed hallucinations in the coqueros of Peru, when under the influence of their dose; and that Von Tschudi saw effects which disposed him to compare *cuca* with stramonium, an unequivocal narcotic poison. I scarcely think the recently ascertained deadly effects of the principle cocaine upon animals can be fairly added to the evidence in the same direction. It is true that experimental inquiries, and, among these, the most recent by Dr. Alexander Bennett, published in his thesis, and also as part of an experimental research carried on by a committee of the British Medical Association,\* prove that in small animals cocaine produces in an adequate dose paralysis of sensation, tetanic convulsions, and death. But he found the same effects to be caused by theine, caffeine, theobromine, and guaranine, the nearly identical crystalline principles of tea, coffee, chocolate, and the Brazilian guaraná; yet no one will imagine on that account, that the habitual use of these restoratives has any injurious influence on the health. At all events, however, the following experiments, with doses little short of those which are stated to have acted so extraordinarily in the case of Dr. Mantegazza, show results materially different from his, and prove that the leaves may be easily used by most, if not all, persons, so as to produce no unpleasant, unsafe, or even suspicious effects whatsoever. It must be acknowledged, nevertheless, from consideration of the whole facts recorded by good observers, and the opinions formed by competent judges, that, if *cuca* is to be added to the restoratives of Europe—which seems not unlikely—it ought to be used at first with caution, and under close observation of its relative effect in several varieties of condition, such as age, sex, and constitution, rest and exercise, bodily and mental, dose and form, etc.

My first trials were made in 1870, when I was not aware that any one else in Europe had experimented with it. My specimen was sent to me by a London mercantile gentleman, Mr. Batchelor, six years before, and must therefore have been kept for seven years at least. The leaves had been excellently dried, flat, unbroken, and green; and they had been equally well preserved by sprinkling a little quick-lime among them before being shipped. Even in 1870 they were green, brittle, and strongly-scented. Two of my students, out of the habit of material exercise for five months, tired themselves thoroughly with a walk of sixteen miles in the month of April. They returned home at their dinner hour, having taken no food since a nine o'clock breakfast. They were very hungry, but refrained from food, and took each an infusion of two drachms of *cuca*, made with the addition of five grains of carbonate of soda, which was added to imitate the Peruvian method of chewing the leaves along with a very small quantity of lime or plant ashes. I am satisfied, however, that any such addition is superfluous. Presently hunger left them entirely, all sense of fatigue soon vanished, and they proceeded to promenade Prince's Street for an hour; which they did with ease and pleasure. On returning home their hunger revived with great intensity; they made an excellent dinner; they felt alert all the subsequent evening, slept soundly all night, and next morning awoke quite refreshed and active. One of them, in setting out for the evening promenade, felt very slightly giddy, as if he had taken just a little too much wine. But the other experienced no other sensation than the removal of fatigue, and ability for active exertion.

Having subsequently received from Dr. Alexander Bennett a larger supply, obtained by him in Paris, I made farther trials in the spring of last year, 1875. This sample was more broken, less green, less scented than the other, less strong in taste, and scarcely producing any sense of warmth in the mouth when chewed. Obviously it was of lower quality. Ten of our students made trial of it under conditions precisely similar to those observed in the prior experiment; and they reported the results to me severally in writing. Their walks varied between twenty and thirty miles, and three cleared the latter distance on a rather hilly road at nearly  $4\frac{1}{2}$  mile pace over all. Two were unable to remark any distinct effect from the *cuca*. Several felt decided, but only moderate relief from fatigue. Four experienced complete relief, like their predecessors in 1870; and one of these had walked thirty miles without any food. All found their hunger cease for a time; but shortly afterwards neither appetite nor digestion was at all impaired. No disagreeable effect was produced at the time or subsequently, except that a few felt a brief nausea after their dose, owing probably to the form of infusion in which it was taken.

I then determined to make some careful personal trials with the scanty remains of my best specimen. For this purpose I thought it

\* *Edinburgh Medical and Surgical Journal*, 1874, Part ii, p. 323.

best to adopt the Peruvian method of chewing, but I discarded their lime and ashes. For not only was I unable to discover, in the nature, composition, or effects of the leaf, any chemical or physiological reason for such addition; but likewise I found that the Llipta, as the addition is called, which was presented to me with one of my specimens from Peru, has no alkaline or calcareous taste, and therefore cannot effect decomposition of the leaf while it is masticated. The result confirms the view I had thus taken.

I had first to ascertain what amount of exercise was required to cause very thorough and permanent fatigue. At the same time, I made such observations on certain of the functions as seemed desirable and easily practicable. In the beginning of May, under a day temperature of 58 deg., I walked fifteen miles in four stages, with intervals of half-an-hour, at four-mile pace, without food or drink, after breakfast at half-past eight, and ending with a stage of six miles at half-past five in the afternoon. I had great difficulty in maintaining my pace through weariness towards the close, and was as effectually tired out as I remember ever to have been in my life, even after thirty miles at a stretch forty or fifty years before.\* Perspiration was profuse during every stage, particularly the last of all. I took the urine-solids every two hours, and found a decided increase of the hourly solids during the forenoon's exercise, and a decrease during the evening's rest after dinner. The pulse, naturally 62 at rest, was 110 on my arrival at home; and two hours later it was still 90. I was unfit for mental work in the evening, but slept soundly all night, and awoke next morning somewhat wearied and disinclined for active exercise, although otherwise quite well. Two days afterwards, I repeated this experiment, and obtained precisely the same results, except that the urine-solids were not so abundant during exercise as before, although my food had been precisely the same.

Four days later, with precisely the same dietary, I walked sixteen miles in three stages of four, six, and six miles, with one interval of half-an-hour, and a second of an hour and a-half. During the last forty-five minutes of the second rest I chewed thoroughly eighty grains of my best specimen of cuca, reserving forty grains more for use during the last stage. To make assurance double sure, I swallowed the exhausted fibre, which was my only difficulty. On completing the previous ten miles, I was fagged enough to look forward to the remaining six miles with considerable reluctance. I did not observe any sensible effect from the cuca till I got out of doors, and put on my usual pace; when at once I was surprised to find that all sense of weariness had entirely fled, and that I could proceed not only with ease, but even with elasticity. I got over the six miles in an hour and a-half without difficulty, found it easy when done to get up a four-and-a-half mile pace, and to ascend quickly two steps at a time to my dressing-room, two floors upstairs; in short, had no sense of fatigue or other uneasiness whatsoever. During the last stage, I perspired as profusely as during the two previous walks. On arrival at home, the pulse was 90, and in two hours had fallen to 72; the excitement of the circulation being thus much less, and its subsidence more rapid, than after the same amount of exercise without cuca. The urine-solids hourly were much the same while the exercise lasted as during exercise on the day of fifteen miles' walking without cuca, although the breakfast dietary was precisely the same. During the evening's rest, the urine-solids were almost the same as during the preceding period of exercise—a fact which is capable of more interpretations than one.† On arriving at home before dinner, I felt neither hunger nor thirst‡ after complete abstinence from food and drink of every kind for nine hours; but on dinner appearing in half an hour, ample justice was done to it. Throughout the evening I was alert, and free from all drowsiness. Two hours of restlessness on going to bed I ascribed to the dose of two drachms being rather large; and after that I slept soundly, and awoke in the morning quite refreshed, and free from all sense of fatigue, and from all other uneasiness. Another effect, not unworthy of notice, was that a tenderness of the eyes, which for some years has rendered continuous reading a somewhat painful effort, was very much mitigated during all the evening.

I reserved what remained of my good specimen of cuca for further trial during my autumn holidays in the country. On September 15th, while residing at St. Fillans on Loch Earn, I ascended Ben Vorlich. The mountain is 3,224 feet above the sea, and 2,900 feet above the highway on the loch-side. The ascent is for the most part easy, over first a rugged footpath, and then through short heather and short deep grass; but the final dome of 700 feet is very steep, and half of it

among blocks and slabs of mica-slate, the abode of a few ptarmigan, of which a small covey was sprung in crossing the stony part. On the whole, no Highland mountain of the same height is more easily ascended. The temperature at the side of the lake was 62 deg.; on the summit, 52 deg. In consequence of misdirection, I had to descend an intervening slope on the way, so that the whole ascent was 3,000 feet perpendicular. I took two hours and a half to reach the summit, and was so fatigued near the close, that it required considerable determination to persevere during the last 300 feet. I was richly rewarded, however, by an extremely clear atmosphere, and a magnificent mountainous panorama, of which the grandest object was Ben-Nevis, forty miles off, shown quite apart from other mountains, and presenting the whole of its great precipice edgeways to the eye. My companions, who, as well as I, were provided with an excellent luncheon, soon disposed of it satisfactorily; but I contented myself with chewing two-thirds of one drachm of cuca-leaves. We spent three-quarters of an hour at the top, during which I looked forward to the descent with no little distrust. On rising to commence it, however, although I had not previously experienced any sensible change, I at once felt that all fatigue was gone, and I went down the long descent with an ease like that which I used to enjoy in my mountainous rambles in my youth. At the bottom, I was neither weary, nor hungry, nor thirsty, and felt as if I could easily walk home four miles; but that was unnecessary. On arriving home at five o'clock, I still felt no fatigue, hunger, or thirst. At six, however, I made a very good dinner. During the subsequent evening, I was disposed to be busy, and not drowsy; and sound sleep during the night left me in the morning refreshed and ready for another day's exercise. I had taken neither food nor drink of any kind after breakfasting at half-past eight in the morning; but I continued to chew my cuca till I finished the sixty grains when halfway down the mountain. I had not with me in the country any apparatus for observations on the renal secretion.

Eight days afterwards, I repeated the experiment, but used ninety grains of cuca. Being better acquainted with the way, no ground was lost by any intervening descent, so that the perpendicular height to be reached from the highway was 2,900 feet. I took two hours and a quarter to ascend, and on reaching the summit was extremely fatigued. The weather had changed, so that the temperature, 51 deg. at the loch-side, was 41 deg. at the top. A moderate breeze consequently caused so much chilliness that my party were glad to redescend in half an hour, by which time I had consumed two-thirds of the cuca, taking, as formerly, neither food nor drink. The effects were precisely the same, perhaps even more complete, for I easily made the descent without a halt in an hour and a quarter, covering at least four miles of rugged ground; and I walked homewards two miles of a smooth level road to meet my carriage. I then felt tired, because nearly three hours had elapsed since I consumed the cuca, and in that time the Peruvians find it necessary to renew their restorative. But there was no more cuca left, and I was tempted to substitute a draught of excellent porter. I suppose this indulgence led on to the unusual allowance of four glasses of wine during dinner, instead of one or none; and the two errors together, with possibly some discordance between cuca and alcohol, were the probable cause of a restless feverish slumber during the early part of the night; but quiet sleep succeeded, and I awoke quite refreshed and active next morning.

One of my sons, who accompanied me on both occasions, used cuca the first time, but also took luncheon on the summit. Though not in good condition for such work, he made it out without fatigue; and on the second occasion, when there was no more cuca to give him, he felt decidedly the want of it when he reached the highway at the foot of the mountain.

These trials have been described particularly, because I feel that, without details, the general results, which may be now summarised, would scarcely carry conviction with them. These are the following. The chewing of cuca removes extreme fatigue, and prevents it. Hunger and thirst are suspended; but eventually appetite and digestion are unaffected. No injury whatever is sustained at the time, or subsequently in occasional trials; but I can say nothing of what may or may not happen if it be used habitually. From sixty to ninety grains are sufficient for one trial; but some persons either require more, or are constitutionally proof against its restorative action. It has no effect on the mental faculties, so far as my own trials and other observations go, except liberating them from the dullness and drowsiness which follow great bodily fatigue. I do not yet know its effect on mental fatigue purely. As to the several functions, it reduces the effect of severe protracted exercise in accelerating the pulse. It increases the saliva, which, however, may be no more than the effect of mastication. It does not diminish the perspiration, so far as I can judge. It probably lessens the hourly secretion of urine-solids. On

\* The degree of fatigue thus occasioned by no great amount of exercise was owing partly to the experimentalist having been quite out of the habit of much exercise for five months, and partly to his having to carry the weight of seventy-eight years.

† See Supplement, p. 53.

‡ Perhaps it should be mentioned that at all times I have been exempt from thirst under a long day's continuous exercise.

at this point I cannot yet speak with any confidence, because it appears to me that the investigation of the action of *paratriptics*, or those substances which seem to lessen the wear and tear of the textures of the body in the exercise of their several functions, involves considerations and precautions which have escaped the attention of experimentalists on this interesting question, and which my own experiments hitherto have not taken completely into account.

I have made no trials of the influence of cuca on disease, or the consequences of disease. Some notices in the journals on this subject show that it is attracting attention ; but, so far as I see, it is a difficult one, and may prove extensive, and therefore it ought to fall into the hands of some able inquirer, who will be in no hurry to rush into print. I have been asked by correspondents in the south of England if cuca will do good to a weak heart, to an old paralysis, to the feebleness of advancing age, etc. My reply has been, that I know nothing of all this, and that no one should use it medicinally, but under the advice and observation of his medical attendant.

A more convenient form for use than that of a quid is very desirable. M. Laumailié, who rode, or on very bad roads led, his bicycle 760 miles from Paris to Vienna in little more than twelve days, in the month of October, carried with him, as part of his scanty baggage, "a small supply of the liqueur de coca, an Indian tonic, by which he was always able to assuage the sudden and painful hunger which sometimes accompanies continued exertion".\* Unfortunately, he gives us too little of his experience with it; but he observes that, when about sixty miles from Vienna, "continuing his way along a road of fluid mire, fatigue and sleep at length told upon him, but the marvellous liqueur de coca again supported him and gave him strength".\* I have made by rule of thumb a very palatable liqueur, with only a fourth of rectified spirit, and containing in half-an-ounce the soluble part of sixty grains of leaves, but I have not yet tested its virtue. Pharmaceutical chemists, however, will soon solve this problem, and, it may be hoped, without looking for a patent.

SUPPLEMENT.

Since producing the preceding account to the Botanical Society, it has occurred to me that, on its appearance in a medical journal, there ought to be some notice of the experiments alluded to on the urinary secretion, although they are incomplete. During their performance, I took exactly the same breakfast—always at half-past eight—viz., twelve ounces of tea, containing 300 grains of sugar and one fluid ounce of cream, not over rich, one egg, weighing two ounces and a half, seven ounces of brown bread, and 360 grains of butter. No food or drink of any kind was taken after that till dinner, about six o'clock. I did not reduce that to positive rule; but, being simple, the nutriment was easily kept nearly equivalent, which was all that was necessary for my immediate object. I ascertained the urine solids separately every two hours during the interval between 8½ A.M. and 4½ or 5 P.M., but at longer intervals in the evening and night. It was sufficient for my purpose to ascertain the solids from the volume and the density, which I took very accurately by the weighing bottle; and in the calculation I used the formula proposed by me many years ago, and found by others to be correct for healthy urine, and which I again verified. This allows 2.33 grains per 1,000 of volume for every degree of density above that of distilled water. I have no doubt this estimate is correct in my own instance, when living, as on the occasion in question, regularly in all respects. More refined results require laborious chemical analysis; but that is not necessary for determining simply the relative wear and tear of the organs of the body, under a few simple conditions, as denoted by the secretion from the kidneys.

The following is a tabular view of my best observations—1, nearly at rest; 2, under hard exercise; 3, under the same hard exercise, but with the aid of cuca.

	Hourly Solids of the Urine under		
	Rest.	Exercise.	Exercise with cuca.
8 $\frac{1}{2}$ A.M. to 10 $\frac{1}{2}$ A.M. ....	27.1 grains	40.1 grs. 3 miles	32.6 grs. 4 miles
10 $\frac{1}{2}$ A.M. to 12 $\frac{1}{2}$ P.M. ....	31.7 "	40.0 " 3 "	32.5 " 6 miles
12 $\frac{1}{2}$ P.M. to 2 $\frac{1}{2}$ " ....	32.9 "	40.7 " 3 "	32.0 " rest & cuca
2 $\frac{1}{2}$ " to 4 $\frac{1}{2}$ " ....	30.8 "	28.6 " 6 "	32.0 " 6 m. & cuca
4 " to 11 " ....	29.0 "	32.9 " rest	33.5 " rest
11 " to 4 A.M. ....	30.7 "	36.0 " sleep	39.5 " slp. disord.
4 A.M. to 8 A.M. ....	33.3 "	32.0 " sleep	27.1 " sound sleep.

It is fruitless to attempt to explain all the deviations here indicated from what might have been anticipated according to received doctrines.

\* *Paris to Vienna by Bicycle*. By W. Saunders. Tinsley Brothers, London, 1875, pp. 7 and 28.

I think I see how further experiment may clear them up. At present, I may only observe that great fallacies surround all inquiries in which the condition of the urine is taken only in the aggregate for four-and-twenty hours ; and that the sudden decrease of urine-solids noted thus\* raises a suspicion that, under a sense of much fatigue, such as was felt at this period of exercise, the action of the kidneys may languish like other functions.

# CLINICAL LECTURE

ON

## A CASE OF PENETRATING WOUND OF THE THORAX.

*Delivered in University College Hospital, London.*

By CHRISTOPHER HEATH, F.R.C.S.,

Holme Professor of Clinical Surgery in University College, and Surgeon to the Hospital.

GENTLEMEN,—I regret to have to bring you into the *post mortem* room instead of the clinical theatre to-day, because I would rather speak of a living than a deceased patient; but the case of injury to the chest which you have watched in Ward I for the last three weeks has unfortunately ended fatally; and, whilst Mr. Barker is making the necessary preliminary steps of the *post mortem* examination, I will recall a few particulars of the patient's history to your memories.

The patient was a healthy man aged 24, a carpenter by trade, who was playing with a fellow-workman on October 29th, when the latter tried to hit him with the flat of an inch-and-a-half chisel, and unfortunately the blade flew from the handle and struck him in the back. When admitted half an hour afterwards, the man was suffering from some degree of collapse; there was some difficulty of breathing, but no hæmoptysis. He was bleeding, but not profusely, from a clean cut wound one inch and a half long, placed between the ninth and tenth ribs of the right side, and parallel to them, about an inch and a half from the spine. Mr. Collins, the house-surgeon, applied a compress over the wound, and gave the patient ice to suck and turpentine to inhale; and, when I came to make the visit about an hour afterwards, you had the opportunity of seeing the case with me. We then ascertained that air passed in and out of the chest during respiration, and this current was strong enough during an effort of the patient to blow out a lighted candle. There was no emphysema about the wound; there was normal resonance over the right side of the chest, and the breath-sounds were healthy. There could be no doubt, then, that the cavity of the chest had been opened and the lung, in all probability, wounded; for, although air might be sucked into and driven out of the pleural cavity by the action of the diaphragm, which would rise to near the level of the wound, the current would not be strong enough to blow out a candle, nor could we explain the flow of blood save by a wound of the lung itself. And yet there had been no hæmoptysis, none of that violent coughing up of florid frothy blood which you may have been led to expect as the invariable accompaniment of a wounded lung, but which does not occur unless some large pulmonary vessel is divided. Again, the admission of air into the pleura did not produce much effect upon the lung, which certainly did not collapse, and, therefore, we had no pneumothorax in the ordinary acceptance of the term.

And next as regards treatment : with a clean cut wound done by a sharp instrument, there could be no question of foreign body in the chest, and no object, therefore, if there ever be, in probing the wound or inserting the finger. To restore the pleural cavity to its normal condition, and to secure rest for the lung, were the objects to be attained ; and I, therefore, had the wound carefully drawn together with plaster, applied collodion over it, and put a broad bandage round the lower part of the man's chest. Then, with the view of preventing the inevitable pleurisy from running too acute a course, I ordered small doses of antimony and opium in combination every four hours, and put him on milk-diet, with ice to suck.

You will find that there have been differences of opinion on the question of closing the opening in cases of penetrating wound of the chest ; but the best authorities are agreed that, in clean cut wounds, union should be encouraged, although it may be necessary later on to reopen the wound or tap the chest to let out accumulated effusions. In our case, as you will hear, Nature saved us any trouble on that score by reopening the wound when the pleuritic effusions had accumulated.