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By FRANK CHARTERIS, M.B.

Last spring two sets of poisoned arrows were sent to the materia medica department of the University, with the request that their action should be investigated, and the nature of the poison determined. Dr. Teacher, who brought the arrows, stated that they had been collected by Mr. Scott in the expedition against the Aros. The account given by Mr. Scott was somewhat imperfect, but it appeared that the arrows were of two types—a smaller variety in use in the inland districts, and larger arrows employed by the tribes living nearer the coast. As regards the activity of the two sets, Mr. Scott indicated that the smaller variety were dreaded chiefly for the poisonous action, while the larger arrows were feared more for the large wound which they inflicted. Both sets of arrows were well made, consisting of light wooden shafts, tipped with long iron points, which, in most cases, were barbed. The poisonous substance was applied to the iron points in the form of a thin coating about one-sixteenth of an inch in thickness. The consistence of this coating differed in the two types. The smaller arrows were covered with a very dry and brittle substance, while in the larger arrows the substance was not brittle, but tough and leathery, resembling in consistence one of the official extracts of the *Pharmacopœia*.

The dry, brittle poison was much less soluble in water than the other form. The small arrows proved to be poisoned with a cardio-muscular poison belonging to the digitalis group. In all probability the actual poison employed was strophanthus. The poison was scraped from the arrows and treated with water. Though only a small amount of the substance dissolved, this solution proved highly toxic for frogs. Injected into the dorsal lymph sac, it caused no irritation. For about fifteen minutes or so the frog remains perfectly well. Then it begins

[1] The expenses of this investigation were met out of a grant from the Carnegie Institute.

to gasp, and is unable to turn over when placed on its back. At the same time, it is noted that the pupils become contracted. The reflexes persist. Fibrillary tremour over the pectoral muscles and lower jaw commences. The frog dies within an hour without developing any spasms or convulsions. Rigor mortis sets in very rapidly. *Post-mortem*, it is found that the muscles with which the solution has been brought into contact do not react to the strongest electrical current. Thus, after dorsal injection, the erectors of the spine and, as a rule, the muscles forming the flanks of the abdomen are dead. Elsewhere the skeletal muscles react, and the cord and nerves conduct electrical stimuli. The reaction of the muscles is faintly acid. The heart is characteristic. The ventricle is firmly contracted in extreme systole, and white in colour, as if all the blood had been squeezed out. The auricles are, as a rule, dilated and full of blood.

Now, this finding shows that we are dealing with a substance which, when locally injected, acts as a muscle poison, and, after absorption, kills the heart, causing the ventricle to stop in systole. This is the characteristic action of bodies belonging to the digitalis group. The action of the poison on the heart could be readily studied in pithed frogs. The central nervous system is destroyed, the thorax opened, and the heart exposed. The application of a few drops of a strong solution to the pericardium rapidly slowed the heart. Thus, a heart beating at 46, after two minutes fell to 36. At the same time the action becomes irregular; after every two or three beats there is a pause in diastole. At this stage the auricles are making one or two beats for each ventricular beat, but in a few minutes the opposite action is noted. The ventricle tends to remain in a semi-contracted form, and relaxation is never complete. At a later stage the only contraction is of a vermicular peristaltic nature, and eventually the heart becomes arrested with the ventricle in extreme systole. Neither muscarine nor atropine is able to start the heart again.

The poisonous element proved to be soluble in alcohol. The alcoholic solution was slightly green in colour. Poured into excess of ether, it gives a copious white precipitate. The dried poison was therefore first treated with ether, which removes fat and some colouring matter. It is then extracted with alcohol. On evaporation, the alcoholic solution leaves a clear, glassy residue, which did not crystallise very perfectly. This residue is readily soluble in water, and produced the poisonous action in frogs. Boiled with a drop or two of hydrochloric acid, the resulting solution reduces Fehling's

solution, proving that the residue is glucosidal in its nature. A watery solution poured on to strong sulphuric acid developed a green colour, which resembled that obtained in a similar way with tincture of strophanthus. It seems, therefore, extremely likely that the smaller arrows were poisoned with strophanthin.

The action of the larger arrows was similar on frogs, viz., a local muscular poison which, after absorption, kills the heart. The active principle is somewhat different, however. As with the smaller arrows, it is insoluble in ether, but soluble in water and alcohol. The dried alcoholic extract is slightly coloured, but does not dry readily. It proves to be a glucoside which has the typical toxic action on the heart and muscles. With sulphuric acid no green tinge is found, but the solution becomes reddish brown. It is possible that the active principle in this case may be pseudostrophanthin or ouabaine. In rabbits it causes no irritation locally, but after subcutaneous injection the rabbit is rapidly affected. Muscular weakness is shown by the animal tending to slip down and recovering itself with a jerk. There is slight fibrillary trembling of the muscles of the neck. Towards the end the heart, which was at first rapid, became slow and irregular. Just before the end there is a brief terminal convulsion, possibly due to anæmia of the brain. Respiration is unaffected.

Immediately after death the ventricles are seen to be arrested in systole, while the auricles are still twitching. In rabbits poisoned with the smaller arrows muscular weakness is not so prominent a feature. Apparently nothing happens for about an hour. Then the animal suddenly becomes uneasy, runs round its cage, and drops down dead. The condition of the heart is similar to that described in the case of the larger arrows.

It is known that strophanthus in various forms is extensively employed for poisoning weapons in Western Africa. Fraser[1] showed that it was used for this purpose in the regions about Lake Nyassa. I examined some large throwing spears got from the upper Benue river, and found that they also were poisoned with strophanthus. Lewin,[2] who systematically examined the arrows in the Berlin museums, found the use of strophanthus very general in Western Africa. Further south the Hottentots and Bushmen use hæmanthus toxicarius, euphorbium, or acokanthera venata, or the poisons of snakes and spiders.

[1] *Royal Society Edin.*, vol. xxxv.
[2] Virchow's *Archiv*, 1894.