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AN ACCOUNT, HISTORICAL AND PHYSIOLOGICAL,  
OF THE MADAGASCAR ORDEAL POISON, THE  
*TANGHINIA VENENIFERA*. By ANDREW DAVIDSON,  
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Court of Madagascar*.

ORDEALS of various kinds have been devised in certain stages of civilization as a means of testing the guilt or innocence of suspected persons. Records have come down to us of the widespread existence of this usage in remote antiquity, and in more recent times ordeals by fire, water, and wager of battle were prescribed by law and sanctioned by religion throughout the whole of Europe. Ordeal by *poison* is, however, peculiar to Africa, although philology renders it probable that the same practice may have prevailed among the progenitors of our own race in prehistoric times.

It is to be observed that these ordeals are chiefly employed for the detection of witchcraft, by which African Jurists understand the use of poisonous drugs for evil purposes. It is in fact equivalent to the *φάρμακεία* of the Greeks; and as the terms *φάρμακός* and *veneficus* were applied by the ancients to signify alike a physician, a sorcerer, and a poisoner, so in many of the African languages the same peculiarity obtains. This arises from the fact that among these and other primitive races the physiological effects of drugs, whether poisonous or medicinal, are ascribed to some magical power, either inherent in the substance itself, or imparted to it by sorcery. Medicines are thus employed as charms both for causing and curing disease. With such superstitious notions of the properties of poisons, it was only natural that they should ascribe the differences in the results observed to follow their administration to a sort of discriminative faculty or intelligence possessed by the substance, and thus have come to employ poisons in the detection of occult crimes, such as witchcraft.

Although we know that the custom of ordeal by poison prevails over a great part of the continent of Africa, we are



as yet unfortunately ignorant, in most instances, of the poisons employed by the different tribes<sup>1</sup>; and, with the exception of the Calabar bean, none of them have been subjected to a satisfactory examination. This is to be regretted from a medical as well as a scientific point of view, as remedial agents of high value will probably be found among these powerful ordeal poisons.

As the advance of civilization has now abolished the use of one of the most celebrated of these ordeals—the '*Tangèna*' of Madagascar—it seems desirable to put on record the mode of administering it and its effects on man, while such information may still be obtained from those who were acquainted with its employment, and had witnessed or experienced its effects. Shortly before my arrival in the island, in 1862, the *Tangèna* ordeal was abolished, but as it happens that an officer, now attached to the hospital, was formerly from hereditary office an administrator of the poison, I have in this way had the opportunity of obtaining trustworthy information upon this subject.

*Historical.*—There is no certain evidence when or how the *Tangèna* first came to be used as an ordeal in Madagascar. We know that some such method of trial has long been practised in the Island. The testimony of Flacourt, who visited Madagascar in the middle of the 17th century, is conclusive upon this point; but if his statements are to be considered as strictly accurate, some other poison must at that time have been used in the district visited by him<sup>2</sup>. Ordeals of other kinds, such as that by plunging the hand into boiling water, were at one time practised in some parts of the country; and there seems reason to believe that the *Tangèna* was not generally or frequently employed until the beginning of the present century.

<sup>1</sup> Dr Livingstone observes that this custom "is common among all the Negro nations north of the Zambesi." The natives of that part of Africa employ a plant called the '*Goho*' which is possessed of purgative and emetic properties.

The poisonous juice of the *Erythrophlaeum Guineense* is employed for the same purpose on the coast of Guinea, and the *Physostigma venenosum* by the natives of Calabar. In the inland regions near the equator, according to Du Chaillu, the natives use as an ordeal the root of a plant or tree called "*Mboundou*" conjectured by Prof. Torrey of New York to be a species of *strychnos*.

<sup>2</sup> He says that the Malagasy administer for this purpose "*Manrechetsi, qui est de quelque sorte d'herbe ou de racine qui est poison et fait mourir celui qui en mange.*" *Histoire de la grande île de Madagascar*,



It was seldom had recourse to in ordinary judicial cases in which more rational modes of trial were followed, but was reserved for the detection of those guilty of infamous crimes, for the discovery of whom ordinary evidence either could not be obtained or would not suffice. Such crimes were treason and witchcraft, and indeed the latter comprehended the former, and for the detection of these it was administered either by order or permission of the sovereign, and in presence of officers appointed by him. An experiment was, however, frequently enough made, *in corpore vile*, in the instance of individuals suspected of minor offences, or in order to decide which of two or more persons was guilty of a crime known or believed to have been committed by one or other of them.

In the former case, a dog having been selected as a substitute for the suspected party, the Tangèna was given to the animal in the same way as when administered to a human being. When again it was given with a view to decide between two or more accused persons, then dogs of similar size and condition were selected, and the party whose representative first succumbed to the poison was treated as guilty.

*Mode of administration.*—The ordinary mode of administration was as follows:—Two Tangèna almonds, or nuts as they are often styled, were taken, and the half of each rubbed down with water. This custom of taking the half of two different almonds was adopted in order to increase the probabilities that the poison administered should be only of the average strength.

The suspected party now ate a little rice and was afterwards made to swallow three small pieces of fowl's skin, and this was followed by the Tangèna emulsion. After a few minutes, varying however according to the result desired by the administrator, tepid water was given in considerable quantities, and violent, long-continued vomiting usually ensued. If the three pieces of skin were discharged the suspicion of guilt was dismissed, as a rule<sup>1</sup>, and the friends of the unfortunate were then left to do their best for his recovery. Not unfrequently, how-

<sup>1</sup> I say "as a rule" for some other omens of an unfavourable kind, which I do not require to detail here, occasionally affected the result.



ever, the poison operated more as a purgative than as an emetic, and then it often happened that with or without the stigma of crime (according as the pieces of skin were retained or rejected) the case terminated fatally. It can easily be understood that state policy readily attained its crooked ends by the administration of the Tangèna. It was observed that those who might be called "*the opposition members of the government*" seldom recovered from the ordeal. So far as can be ascertained, it proved fatal in as many as one in ten cases when given with no hostile intention. As it was often administered to whole villages at once, it will be understood that the numbers destroyed by this poison were immense.

The points especially affecting the result seem to have been:—(a) The colour of the kernel; the very red ones are said, and probably with truth, to be more poisonous than the less ripe ones, which are whiter in colour. (b) The amount administered was in every case enough to prove fatal, if not speedily rejected. From what I have learned from the natives, as well as from the results of my own experiments, I have no doubt that the weight of one almond is amply sufficient to poison an adult, if not got rid of by vomiting. (c) If administered on an almost empty stomach, it was more dangerous than when a larger quantity of rice had been previously taken. (d) A great deal depended upon the seasonable and reasonable administration of diluents. Experience enabled the expert to judge the time when to give drink, and the amount required to effect his object, whether that might be the death or recovery of the victim.

*Symptoms.*—As the result of a careful examination of several who have been themselves subjected to this ordeal, and of many who have witnessed its effects on others, I conclude that the symptoms produced by it when given in poisonous doses, in the manner just described, are as follows:—A peculiar numb tingling sensation is felt in the mouth and fauces, due to its topical action. Several of those who have undergone the ordeal have assured me that they experienced a similar feeling more or less over the whole body, but especially in the hands. This point is important, for my experiments on warm-blooded



animals have not indicated any noticeable disturbance of sensation. Sickness ensues with vomiting, intense, distressing and repeated—first of the contents of the stomach—then of bile and mucus. The vomiting is attended by a feeling of great debility and anxiety. If the greater part of the poison has been thus ejected, the patient recovers perfectly within a short time. Where more of the poison has got into the circulation the sufferer is said to feel giddy. The Malagasy, however, use their word for vertigo in a loose sense. I am therefore inclined to think that partial paralysis of motion with unsteady gait may be the condition indicated. The patient, under the influence of the Tangèna, staggers if he attempts to walk, is unable to support his own weight, and falls down helpless and paralysed. Although the mind is usually clear, yet delirium *occasionally* occurs. Along with these nervous and cerebral symptoms, purging and urination appear and are more or less urgent. The fæcal discharges do not contain blood or mucus. Nothing abnormal has been observed by the natives in the appearance of the urine. The patient in cases tending to a fatal issue becomes unable to rise. In other instances, according to the testimony of observers, he lies as if asleep, and when roused answers like a drowsy man, then lapses back into his former condition. In other cases the patient remains conscious to the last, without either stupor or delirium. Death is preceded by spasmodic movements of the fingers and toes. Purging is a bad symptom and worse the more urgent it is. Almost none recover when the stage of stupor has been reached.

The natives know of no antidote for this poison, but they think that the application of cold and draughts of lemon-juice are of service.

I may remark upon the condition of sleepiness described above as of pretty frequent occurrence in the advanced stage of poisoning by this substance, that I do not believe that my informants were able to distinguish between narcotism and a state of prostration. I have however given their statements literally.

Upon this point I may further observe that my experiments on the lower animals do not seem to countenance the opinion of some, that there is any narcotic property in the substance.



There is only one exception to this statement of the result of my experiments. In two instances in which I administered the Tangèna to fowls, they appeared to be overcome by sleep.

No post-mortem examination has been made of those who have died by Tangèna.

*Botanical note.*—The Tangèna, or Tanghin (*Tanghinia Venenifera*; *Cerbera Tanghin*, Hooker), is a large tree of the natural order *Apocynaceae*. The poisonous part of the plant is the fruit, which is a *drupe*, almost the size of an apple. The colour of the fruit is a greenish-yellow; the external pulp which surrounds the kernel is soft, somewhat grey in colour, destitute of smell, and possessed of a slightly bitter, disagreeable taste. The kernel is hard, ligneous, and brown, and elliptical in shape. Within this is the almond, which is divided into two cotyledons, of the consistence of a newly-plucked bean, varying in colour from a white to a brownish-red; and weighing from forty to seventy grains. For a minute botanical description of the tree and its fruit the reader may consult Hooker's *Botanical Miscellany*, III. 290. The Tangèna grows abundantly in the forests on the east coast of Madagascar, it is rare in the central provinces, and towards the south of the island.

*Chemistry.*—Two crystalline principles are said to have been obtained from the Tangèna: the one, the bitter principle *Tanghinin*; the other, the poisonous principle which has been named *Tanghicine*, and is described as transparent plates obtained by æther, insoluble in water, bitter and poisonous. I have no access however to any account of the process followed in the separation of these; and I shall state in a few words what little I know upon this point.

(a) The kernel contains a large quantity of an inert, bland oil, and if rubbed up with water it forms a white emulsion.

(b) Its active principle is insoluble, or at least nearly so, in water, readily soluble in alcohol, æther, and chloroform, as is proved by the activity of the extracts made by means of these solvents.

I have obtained by means of chloroform impure crystals, in the form of long, flattish needles, arranging themselves under the microscope as if branching out at acute angles from a centre.

(c) By treating a carefully prepared alcoholic extract with water a white precipitate is obtained.

In my experiments, I have used the simple emulsion, and extracts made with æther or alcohol, and in a few instances the impure crystals mentioned above<sup>1</sup>.

<sup>1</sup> I have given the above as it was written more than three years ago. As my object was not to investigate its chemical properties, but its physiological action, I had neglected to note down the *steps* of the process by which I obtained the crystals alluded to; and I cannot now add anything from memory. The recent work by Chatin (*Recherches pour servir à l'histoire botanique, chimique et physiologique du Tanguin de Madagascar*. Par Joannes Chatin, Paris, 1873) upon this poison would render it probable that the active principle



*Physiological Action.—Results of experiments on the lower Animals.*

The Tangèna proves fatal by absorption however introduced, whether into the alimentary canal, the serous membranes, or into the cellular tissue. It acts less actively if swallowed, because partly got rid of by vomiting. When a concentrated solution of the poison is applied to the frog's foot it is slowly absorbed and causes death. Ligature of the blood-vessels prevents or delays its action.

(A). *Topical Effects.*

1. Its topical action on the mucous membranes is to alter and diminish the sensibility in the part. The same results follow its application to the skin.

2. Its local action on muscular tissue is no less evident. Applied to the exposed heart of the frog it produces *immediate paralysis*. It acts with equal rapidity on the excised heart which is still pulsating. The electric contractility of the poisoned muscle is diminished or destroyed. Applied for about thirty minutes to the leg of a frog, the part is paralysed, and if pricked or pinched, is insensible or nearly so; all the while the animal is lively, and the blood continues to circulate naturally in the web of the affected foot. After the lapse of about an hour, the other leg becomes paralysed, then the upper extremities, and finally death occurs in an hour and a half, or two hours.

3. When applied to the exposed sciatic nerve, paralysis followed by death has also been the result; but I am unwilling to deduce any conclusion from this, as, from the difficulty of

is *not* a neutral body, but an alkaloid which he obtained thus:—Having first got rid of a considerable part of the oil by pressure, he made an ætherial extract, which was treated by warm alcohol, and on evaporation left a residue which he thus describes: “la liqueur évaporée dans la vide laissa un résidu assez considérable, brunâtre, légèrement amer et comme granuleux en certains points; facilement fusible, ce produit, chauffé au contact de l'air, se comportait comme un corps gras. Le produit ainsi obtenu était toxique; je le traitai alors par de l'acide acétique étendu et j'obtins, par l'évaporation des liqueurs, une petite quantité de poudre blanchâtre, assez soluble dans l'eau, beaucoup plus soluble dans l'alcool. Elle fut en conséquence traitée par ce dissolvant et, par l'évaporation dans la vide, elle donna de petits cristaux, d'un blanc vitreux et appartenant au système diclinorhombique” (p. 30). This subject will still require further investigation.



localizing the poison, I am not quite satisfied that it did not come into contact with the exposed muscles.

4. When applied to the conjunctiva it does not affect the pupil.

(B). *Action through the Circulation. (On warm-blooded Animals.)*

1. However introduced it produces violent vomiting and purging in all animals capable of these actions. As an emetic, Tangèna is even more violent, and operates sooner when introduced directly into the circulation than when swallowed.

2. It produces marked paralysis of motion, apparently more intense at first in the lower extremities, and last of all affecting the muscles of the trunk and neck<sup>1</sup>.

3. When it acts through the circulation, sensation seems slightly if at all *paralysed*. Pinching the tail of a lemur makes it suddenly exhibit signs of pain, long after it is incapable of motion. Other facts seem to prove that sensation is *altered*, *not abolished*.

4. The animal remains conscious and observant to the last; excepting in fowls, as already mentioned, I have never seen narcotism induced.

5. The action of the heart is first somewhat increased (at least in some cases), then it becomes weak, irregular and slower, and finally stops a short time before the respiration. The heart's action is arrested in systole. The ventricles usually contain a little blood but are never distended. The blood is sometimes slightly coagulated, but more commonly fluid. The auricles and venæ cavæ are engorged.

6. In one case I noticed peristaltic movements of the right auricle, continuing for half an hour, or longer, after death, excited by mechanical or chemical stimuli; and in another case, this peristaltic movement was observed to occur *spontaneously*, twice a minute, producing a wave-like motion in the venæ cavæ.

<sup>1</sup> It must be remarked, however, that in these experiments the poison was injected into the cellular tissue over the loins. This fact should be kept in view as it suggests an explanation of this observation.



7. Idio-muscular twitchings of the pectoral muscles are commonly observed if the body be examined soon after death.

8. After death by Tangèna, I found the muscles to contract on applying strong magneto-electric stimulation, but less perfectly and persistently than natural; but after the direct application of the poison to a muscle, its irritability by electricity is much more distinctly diminished, or even destroyed.

9. The liver is always much congested, and notwithstanding the urgent vomiting, the gall-bladder is sometimes full. There are usually no signs of irritation, or injection of the mucous membrane of the stomach or bowels. There is no congestion of the brain or cord. The lungs are always exsanguine and collapsed.

(C). *Action on Frogs.*

1. However introduced, Tangèna tetanizes the heart, with varying degrees of rapidity, according to the size of the frog, the amount of poison used, and the mode of administration.

The pulsations usually first increase in number, then become less frequent, while from the first they tend to be irregular—afterwards this irregularity becomes more marked. After some time, tetanic contractions of distinct portions of the substance of the ventricle take place, the tetanized portions remaining pale; then complete tetanus of the organ ensues, preventing all further entrance of blood. The auricles continue to contract after the ventricle has ceased. The ventricle sometimes stops for a little and then begins to act again. After death the auricles are distended and the ventricle is contracted and pale. As already stated, the heart's action is immediately arrested by the topical application of the poison to its substance. In this case it is paralyzed not tetanized.

2. The heart ceases to beat before respiration and reflex action are abolished. The decapitated frog, whose heart has been arrested by Tangèna, will draw up its legs on being irritated, unless indeed the paralysis of the extremities has been very complete before the experiment has been tried.

3. Destruction of the medulla, or decapitation, does not prevent, although it perhaps somewhat delays, the action of Tangèna on the heart.



4. The pulsations of the posterior lymphatic hearts become rapid, irregular and excessively weak, and seem to cease at the same time that the heart's action is arrested.

5. The extremities are always more or less paralyzed. After a pretty large dose, the frog remains with its posterior extremities extended, and it requires strong stimulation to excite any movement.

6. Reflex action is probably *diminished, not immediately*, but soon after the administration of the Tangèna. This I ascertained by suspending two frogs, of the same size, by the lower jaw. I gave one of them a small dose of Tangèna (a grain of the semi-liquid spirituous extract), and then by the application of similar mechanical and chemical stimulants, observed the readiness with which in either case reflex movements followed.

7. The muscles can be made to contract by the magneto-electric current after the paralyzed limb has been amputated, but less actively and for a shorter time than in a healthy one. If a ligature be applied to the sciatic artery and vein, the limb below the ligature will be protected from the poison and will contract actively, if the magneto-electric current be applied; while the poisoned limb remains motionless, or nearly so, whether the stimulus be applied through the nerve, or to the muscle.

#### *Experiments on warm-blooded Animals.*

Exp. I. *On a Lemur.*—At 7.58 A.M. Ten grains of a liquid extract of *Tanghinia venenifera*, mixed with one drachm of water, were injected into the cellular tissue in the lumbar region of a full-grown lemur. 8 A.M. The extremities are weak—scarcely able to walk. 8.7. Vomits frothy mucus. 8.15. Continues to vomit, and when it attempts to walk, its movements are slow and uncertain, it is unwilling to move; the heart's pulsations are reduced in frequency, pupils normal. 8.17. Lying on its belly with its legs stretched out and flaccid, sensation perfect. 8.24. Limbs paralysed; pinching the tail makes it look round, and it makes vain attempts to change its position, pulsations of the heart less frequent and weaker. It is perfectly conscious, for although unable to move its limbs, it follows with its eyes the movements of any one approaching it. 8.30. Heart irregular, two pulsations and a pause; pupils a little contracted (?), sensation unaffected. The heart is now becoming slower



and slower, the respiration panting. 8.35. The heart only beats occasionally, sensation seems perfect, it is able to move its head a little, but the rest of the body is paralyzed. 8.40. Respiration panting, and forty per minute. 8.45. Paralysis complete, sensation unaffected, the pulsations of the heart very infrequent, after a considerable interval a few hurried beats succeed each other. Slight shivering movements in the tail, fingers and toes (*spasmodic*). 8.47. The heart has ceased to beat, the pupils are dilated, the lower jaw has fallen, a few gasping respirations. 8.47. Slight spasmodic movements in the feet. 8.48. Died.

9.4. Opened the body and observed spontaneous twitchings of the pectoral muscles, which also were excitable by mechanical irritation. Auricles and great veins very much congested; a little semi-coagulated blood in right ventricle; a drachm of fluid blood in left ventricle, which coagulated after removal. For half an hour after death the application of dilute sulphuric acid or mechanical irritation produced contractions, especially of the auricles, which from being dark red became temporarily pale and bloodless; pinching the substance of the ventricles made them contract, the contraction of the latter did not extend to the auricles; lungs collapsed and pale; liver congested, gall-bladder full, vena porta congested, stomach and alimentary canal healthy.

Exp. II. *On a Cat* (nearly full-grown).—After applying a spirituous extract of *Tanghinia v.* to the conjunctiva in order to observe its action on the pupil, with a negative result, and having ascertained the pulsations of the heart to number nearly 120 per minute, at 12.15 P.M. we injected three grains of the same extract, mixed with one drachm of water, into the cellular tissue. 12.20. The animal is able to walk, but its legs seem weak. 12.31. Begins to vomit. 12.37. The action of the heart weak, pulsations about 110 per minute, the vomiting urgent, bowels moved. 12.43. Vomiting still continues, great debility, the pulsations of the heart very much reduced in number and strength, the respirations fewer and panting, pupil normal. 12.50. The animal is now scarcely able to move about, it lays its head down upon the ground, and after a little changes it into a new position, without moving its body. How far this condition results from paralysis, and how far from pure debility, it is difficult to say. 12.52. Pulsations of the heart 20 per minute, and weak. 12.54. Clonic spasms of extremities, with trembling motion of the skin of the back, expulsion of urine and fæces, a sigh, the pupils dilated, the action of the heart has ceased, a few gasps, and the animal died at 12.57.

*Examination immediately.* Lungs pale and collapsed, the coronary veins of the heart full, the substance of the heart congested, all the chambers contain blood, the auricles however are *engorged*, the left one full of bright red and watery blood, the venæ cavæ full. The liver, vena porta and its branches, are very much congested, the whole intestinal canal abnormally pale. A mild magneto-electric cur-



rent produces contractions of the muscles to which it is applied, the contractions are less powerful when the current is transmitted through the nerve, slight contractions can be produced by connecting the two limbs, the heart does not respond to the magneto-electric stimulus. I have observed paralysis to be much less distinctly marked in the cat than in the lemur.

Exp. III. *On a species of Civet about the size of a small cat.*—The poison mixed with a little water was injected into the cellular tissue at 9.24 A.M. At 9.25, makes violent efforts to vomit. 9.28. Restless, and vomiting. 9.37. Posterior extremities are paralyzed, sensation seems unaffected. 9.40. A slight shivering motion all over its skin; extremities paralyzed, but it is still able to move its head a little. 9.42. It is now quite unable to move any part of its body. Died at 9.45.

*Examination immediately.* Great congestion of liver, kidney, portal vein, and substance of the heart. Right auricle engorged. The right auricle was seen to make about two slight contractions every minute, producing a wave in the blood, filling the vena cava descendens. These contractions were spontaneous; but after they ceased they could be excited again by mechanical irritation of the muscular substance for about half an hour after the organ was exposed.

### *Experiments on Frogs.*

The experiments made on frogs were very numerous, and every experiment repeated frequently by my assistant, Andrianaly. Two species of frog were used, the one very considerably smaller than the common English frog, *Rana Temporaria*; the other about one-third larger. I shall select a few experiments from my note-book to illustrate some of the points referred to in the preceding observations.

Exp. IV. *To ascertain the effect of the local application of the poison.*—A little of the common extract was applied to the right leg of a frog at 9.20 A.M. At 9.58, the right leg is observed to be paralyzed, pinching it does not produce any sign of sensation, the left limb normal. 10.30. The left limb is now paralyzed. 10.40. The paralysis has extended to the whole body, and is gradually becoming more marked. The animal died about 11.15.

The two following experiments illustrate the action of *Tanghinia* on the heart.

Exp. V. At 9 A.M., exposed the heart of a large frog, the pulsations were about 52 per minute. 9.5. Injected about one grain of



the extract of *Tanghinia ven.* into the peritoneum. 9.8. Pulsations 52. 9.15. They became reduced to 39. At 9.20, the tetanized ventricle was seen to contract imperfectly, and at 9.21 the heart and respiration ceased almost simultaneously; but although the heart has ceased to beat, the animal made a few leaps. On looking at the posterior lymphatic hearts, we find they have ceased to beat. 9.28. The animal still continues to withdraw its legs if they are drawn out.

Exp. VI. Having exposed the heart of a large frog, and found the pulsations 42 per minute, at 7.15 we administered one grain of the extract of *Tanghinia v.* by the mouth. The action of the poison on the heart was as follows:—

7.20.	The pulsations were	34.
7.25.	„ „	29.
7.30.	„ „	28.
7.40.	„ „	26, and irregular.
7.50.	„ „	24. The ventricle contracts very imperfectly.
8.	„ „	22. Slight vermicular motions of the ventricle.

8.10. The ventricle has ceased to beat, the auricles however make 12 pulsations per minute. 8.20. The auricles have stopped; but respiration has not quite ceased, and the animal is still able to move. The head was now removed, leaving the lower jaw connected with the body. Reflex movements could be induced by pinching, or by the application of electricity. The ventricle was contracted, and the auricles dilated.

Exp. VII. We selected two large frogs of about the same size, and having exposed their hearts, we administered two grains of the extract of *Tanghinia v.* by the mouth to one of them; and in order to test the action of the poison on the reflex functions of the cord, suspended them by the lower jaw, and observed the length of time which elapsed between the application of dilute sulphuric acid and the appearance of the corresponding reflex movements. We found the reflex movements to be less energetic, and slower in appearing in the poisoned frog; and after about an hour, scarcely any irritation could induce reflex movements; yet after death we found the muscles to contract, when magneto-electricity was applied, although less actively, and for a shorter time than the muscles of the non-poisoned frog. We observed in this same experiment paralysis of the lower jaw, which appeared almost immediately after the administration of the poison, and was probably owing to its topical action on the muscles and nerves. The pupils became much dilated within ten minutes after the poison was given, and continued at least double the size of the pupils of the non-poisoned frog. The posterior lymphatic hearts were also observed in this experiment, inasmuch as they receive their nervous supply from the cord. In the non-poisoned frog, the posterior lymphatic



phatic hearts continued to beat throughout the experiment at from 48 to 50 per minute, and the pulsations were *distinct, strong, and regular*. In the poisoned frog, they very soon rose in number: ten minutes after the administration of the poison they had risen to 63; after half an hour they were 77, and weak, and they gradually became weaker and more irregular, and after the lapse of an hour were quite imperceptible.

There is very great difficulty in deciding to what extent the conductivity of the motor nerves is affected, inasmuch as the poison affects the contractility of the muscles, and this complicates the matter very considerably. We constantly observe voluntary motion remarkably affected before the reflex functions of the cord are much diminished, but this loss of voluntary motion may of course be due to other causes than the mere loss of motor conductivity. Although I do not consider it proved, I think it probable that the helplessness and dragging of the limbs are partly owing to poisoning of the muscular tissue, and partly to paralysis of the motor nerves. It seems impossible to doubt that the irritability of the nerves and contractility of the muscles are lessened, and they are thus less able to respond to the influence of volition, while, on the other hand, this manifestation of reflex movements in the decapitated animal poisoned by *Tanghinia* proves that the muscles nevertheless retain enough of irritability, and the nerves enough of conductivity, to make it impossible to ascribe the paralysis entirely to these two causes. Admitting then these conditions as existing, I am inclined to think that the anterior columns of the spinal cord are also implicated, and that the paralysis, as I have already said, is partly due to this cause.

Exp. VIII. We decapitated a small frog in order to test the length of time that reflex movements may be excited by mechanical and chemical stimuli. 9.11. The frog was beheaded. 9.16. It draws up its hind legs if disturbed. 9.18. Makes attempts at leaping. 9.22. Pinching the foot produces movements in all the extremities. 9.31. Applied some dilute acid to the skin, and strong reflex movements followed. 9.40. Reflex movements cannot be any longer induced. In this experiment reflex movements persisted for nearly half an hour. A frog of similar size had its heart exposed, and a grain of *Tanghinia* injected beneath the skin of left leg. The pulsations of the heart rose from 80 to 100, and in two minutes stopped. The posterior lymphatic hearts stopped at the same time as the blood heart. We now cut off its head. Touching the eye induced pro-



tective motions of the eyelids. Pinching the feet did not bring on any reflex motion, but acetic acid applied to the fore-legs did. *Six minutes after the heart ceased to beat, all reflex action ceased.*

In repeated experiments in which the amputated limbs of frogs have been immersed in a mixture of *Tanghinia* the contractility of the muscles has been lessened in a very few minutes, and after a somewhat longer time abolished.

Exp. IX. We selected a large active frog, and tied the vessels of the left posterior extremity, and then poisoned it with extract of *Tanghinia* given by the mouth. The muscles of the limb so protected were found to contract much more energetically than those of the other, and that whether the stimulus was applied through the sciatic nerve or to the muscular substance itself.

Several experiments were made to ascertain whether destruction of the medulla would affect the action of the poison on the heart. In one case in which we decapitated a frog, and then injected one grain of the extract into the peritoneum, the heart continued to contract for twelve minutes after the injection of the poison, and dilute sulphuric acid induced reflex movements for some time after the heart was arrested. We may conclude that *Tanghinia* does not arrest the heart through any action on or through the vagus.

### *General Conclusions.*

(a) The Tangèna must be classed among the cardiac poisons. It uniformly causes death by arresting the action of the heart.

(b) It does not act on the heart through the vagus nerve. When applied to the exposed heart its rapidity of action is remarkable. The fact that it arrests the pulsations of the excised heart of the frog is conclusive proof that its influence, when topically applied, is direct, either on the muscular substance, or the muscular substance *and* cardiac ganglia.

(c) There is sufficient reason to believe that the Tangèna acts on the spinal cord, producing paralysis and diminishing reflex action.

(d) Voluntary motion is abolished, and the irritability of the motor nerves lessened by the poison. When it acts through



the circulation in mammalia, sensation is not remarkably affected; muscular contractility is very much diminished. More exact knowledge of the degree and order in which these various functions are affected, can only be obtained by carefully performed experiments made in Europe, where the more delicate electrical instruments can be had.

(*e*) It is exceedingly fatal to man, in doses of thirty grains of the kernel, if not promptly ejected.

(*f*) It causes a numb, tingling sensation in the part with which it comes into contact, and also throughout the body.

(*g*) It is powerfully emetic and purgative, produces great nausea and debility, paralysis of motion, occasionally delirium, narcotism, and perhaps vertigo.

(*h*) It may be inferred to cause death in man, as in all other animals, by tetanizing the heart.







