The Struggle against Scorpions

by

Dr. EZEQUIEL DIAS, Dr. SAMUEL LIBANIO and Dr. MARQUES LISBOA.

(With plate 1).

In accordance with the life-habits of the *Scorpionidæ* of Central Brazil and specially of the State of Minas Geraes, the chosen sites for any campaign against these pests should be:

1º. The fields.

2º. Human dwelling-places.

Given their enourmous geographical distribution, the first part of the problem did not appear to us feasible or opportune. Only, had civilisation attained such a degree and the exchequer such means as to warrant a similar campaign of extermination, would we be enabled to commence the struggle in the scorpion's own habitat, the open country, whence it came and still comes to our estates.

In Mexico, where *Centrurus gracilis* causes frightful accidents such an attemp has evidently been made, for the authorities even distributed rewards for the extermination of these pests. In one summer alone, according to TASCHENBERG, 80.000—100.000 of them were destroyed.

The INSTITUTO OSWALDO CRUZ of Bello Horizonte (Minas Geraes) although not aimig at the extermination of these pests, can usually estimate how feasible this curious hunting really is, when it undertakes the making of scorpion antivenin: in 6 years it was able to acquire 107.533 live and dead specimens, at a total cost of 9:941$950, brazilian currency.

Let it remain clear, however, that for the time being we do not entertain any idea of establishing a systematic campaign by this method. On the other hand, there is not the slightest doubt that, where a similar purchase has been put into practice, the number of scorpions suffered a considerable decrease.

———

What appears feasible at the present time is the second part of the problem, viz. the destruction of scorpions infesting houses and their approaches. With this end in view we studied three orders of measures:

a) Scorpionicide substances.

b) Building of houses unsuited to the harbouring of scorpions and their young.

c) Accesory measures.

I

SCORPIONICIDAL SUBSTANCES.

PRELIMINARY TESTS.

With a view to gathering an idea of the scorpion's resistance we began by practising several laboratory experiments, some of them *in vitro*.

We worked on the species most common in the Bello Horizonte district— *Tityus serrulatus* and occasionally on *Tityus bahiensis* and *Tityus dorsomaculatus*. At first we supposed, as was done currently by authorities on the subject, that there was only one species in the region, *Tityus bahiensis;* but A. LUTZ and O. MELLO very rightly established the two new species, separating them from *Tityus bahiensis*.

Besides this, to render our work more useful and at the same time perhaps more instructive we also submitted to our experiments some parasitic insects and other noxious or troublesome pests.

Action of Xylol.— It was natural that we should first remember this insecticide so extensively used by entomologists and collectors.

We submit the following protocol of our experiments:

At 4 p. m. a scorpion was placed in a wide-mouthed flask stoppered with cotton-wool on which 4 drops of Xylol were spilt. At first the subject remained motionless. After three minutes it began to show agitation only to fall afterwards to the bottom of the flask, always in contractions: there it remained half deal dead. The last part of it to lose action was the caudal extremity, the seat of the poison sting. Half an hour later, it still lay inert, the ventral side uppermost so that body and tail formed a continuous curve. From this time on it showed no sign of life. Next morning death was confirmed.

The same chemical agent kills under similar conditions lice, fleas, cockroaches, ants, spiders, flies, mosquitoes and silver fish (lepisma); even the *barbeiro (Triatoma megista)* in spite of its enourmous vitality was unable to resist its toxic action.

Chloroform (*).—A scorpion was placed inside a big flask, containig also a BORREL tube with 2cm³. of Chloroform. No period of excitation. The scorpion walks round the bottom of the flask. Gradually its movements become slower: a few minutes later it becomes paralysed and the sting from having been upright falls to one side: it still reacts to external stimulus. Shortly afterwards, slight excitement: the sting is lifted, the body motionless, legs and maxillary palpi held away from it and the sting bent over it. At the sting is affected by trembling. Half an hour after the commencement of the experiment external stimulus still provokes small movements of the last caudal segment. 45 minutes later no sign of life is shown wherefore it is removed from the flask. The tail still reacts upon stimulation. Death.

Hydrocyanic Acid.—Under a glass bell, resting on a wooden board with a circular groove full of water allowing the glass bell to fit exactly and completely isolating it, were placed a glass with three cubic centimetres of water and one of sulphuric acid. A small sack containing 1 gramme of potassium cyanide hung from the stopper of the glass bell in such a way as to plunge into the glass just when the stopper

---

(*) Experiment carried out thanks to the courtesy of Dr. OSWALDO MELLO.

shut the opening of the glass bell. By means of this device hydrocyanic (prussic) acid could be formed rapidly with or any danger to the operator or any loss of gas.

After ten minutes in this medium there died: a scorpion, about ten bugs, a nymph of *Triatoma (barbeiro)* and a white rat. The least resistant proved to be the white rat, the hardiest the scorpion.

Gasoline.—In a dose of three drops, under the same conditions as Xylol, Gasoline is unable to kill scorpions, in spite of the suffering it produces. Yet it kills ants, bugs etc. so that it would seem likely that a greater dose would be more effective against scorpions.

Naphtalens.—Under a glass-bell were placed without being insulated: in the middle 5 grammes of naphtalene in a porcelain-capsule, heated by a spirit-flame; round it, several animals for experiment, each one it its owen tube stoppered with cotton-wool.

Immediately a great quantity of gases, nearly black in colour were seen to rise from the naphtalene and at the end of an hour fine white crystals could be seen deposited everywhere. We submitted to the experiment: one scorpion, two bugs and one *Triatoma:* They at once become agitated, specially the mouse which at the end of three hours is sad, prostrated and dyspnoic. The scorpion appeared to be suffering considerably: it had violent convulsions, whirling around in all directions, sometimes with its ventral side uppermost, and with is drop of venom shing on the tip of its sting. The *Triatoma* and bugs, also lying on their backs, occasionally moved some of their limbs.

Results: mouse died 5 hours after the commencement of the experiment; bugs, one of them after 5, another after 15 hours; scorpion-died within 13 hours; Triatoma within 15 hours.

Coal gas.—Gases obtained from the heating of anthracite (stone-coal), in a retort, were led to a glass containing 1 scorpion and 1 *Triatoma.* 1/4 hours afterwards they were agonising and shortly afterwards dead. During the experiment some humidity was formed, which perhaps contributed towards the rapidity of this result. Yet the same experiment repeated without this source of error gave the same result in the case of 2 *Triatoma*-larvæ and two lice (on this day no scorpions were available).

Carbon Sulphide.—In a glass under a hermetically shut bell, 5 cm³. of Carbon Sulphide. In 1,15 hrs. 1 scorpion and 4 cock-roaches were killed. Under same conditions, 1 scorpion was killed in an hour. Still under the same conditions, only a spider had been killed; 1 scorpion, 2 cockroaches and 2 other spiders resisted.

Sulphur Dioxide.—At 12,43 a scorpipion is placed in a big glass full of Sulphur Dioxide (Sulphurous Acid Gas). Immediate excitement. At 1 p. m., violent but short-lasting excitement; the scorpion then falls, as if dead to the bottom of the flask. Upon being removed from the flask it still shows some signs of life, but these cease after time and cannot be produce by stimulation. Death.

———

From these slight preliminary tests we may conclude that there exist safe and sure means of killing scorpions; and, furthermore, that for this purpose we might rely on the action of hydrocyanic acid, coal gases, sulphurous gas, carbon sulphide, xylol, chloroform and naphtalene.

Regarding the doses of toxic gases to employ, we were unable to re-establish the observations of E'MILE BLANCHARD who confirming the results obtained by WILLIAM EDWARDS on in-

seels, noticed that an excess of gas is unfavourable, since under these conditions scorpions cease to breathe, relying upon their breathing apparatus and their meagre needs; whereas when the air is merely vitiated, death ensues rapidly, for the animals do not cease to breath and are gradually poisoned.

It would have been desirable that these authors should have proved to be right, for then the destructions of these pests would be much easier.

EXPERIMENTS IN SMALL COMPARTMENTS.

With a view to obtaining a gradual approach towards the natural conditions under which scorpions would have to be fought, we undertook experiments in less restricted spaces.

We made use of our photographic room (7,300 square meters) in which the animals were placed always far from the entrance of the toxic gases, which were produced outside and carefully conducted by canalisation. Gummed paper was employed to seal the room in hermetically. We were always, careful, because the gases we worked with *were* sometimes inflammable as well as toxic.

The following are some of the experiments:

Acetylene Gas.—Length of the experiments: 21 hours. Results: negative for scorpions, *Triatoma*—larvæ, adult, Triatomata, bugs and cockroaches. Positive for rats, the only animals to succumb.

Chlorine.—After 24 hours there remained alive, a scorpion, *Triatoma*-larvæ, cockroach and a rat.

Formaldehyde.—Used in the HOTON apparatus it once more proved to be of very little avail since it did not kill a scorpion in 24 hours.

Coal Gas.—Gases obtained by heating 1/2 kilogramme of coal in the native state proved to be harmless for scorpions, *Triatoma*-larvæ, rats and cockroaches (24) hours).

———

Fearing some accident in our photographic room, which is of wood, we took to working in one of the basement rooms of the Institute (52 cubic metres).

Under these conditions we tested:

Creolin.—In iron-pans placed inside the compartment, creolin was heated in the proportion of 10 cubic centimetres for every cubic metre of space. Result after 24 hours: negative for scorpions, bugs, cockroaches, mice and rats.

Naphtalene.—Under the same conditions 14 grammes per cubic metre were heated with equally negative results.

Pitch.—Ditto, ditto 12 grammes for every cubic metre with the same results. In this experiment we were unable to avail ourseves of a scorpions, but by the resistance of the other animals we could estimate the inefficiency of the process.

Brazilian Stone-Coal.—4 kilogrammes heated during three hours. The gases generated were led to the compartement which remained closed for 24 hours. Harmless for scorpions, cockroaches, rats and *Triatoma*-larve.

Acetylene Gas.—6 kilogrammes of Calcium Carbide during 24 hours. Under the same conditions it gave same results.

Chlorine.—In 24 hours it did not kill scorpions, Triatomata, cockroaches or rat.

Sulphurous Gas.—We were obliged to abandon many of the substances above in view of their inefficiency, when used in ample spaces. We also feared to make use of the best of them—hydrocyanic acid—on account of its poisonous nature. Nevertheless it is extensively used in the United States in the fumigations of infected trees, especially in the orange plantations of California. There they make use of a very original process which might perhaps be put into practice

on *Triatoma*-infested mud-huts. The work, there, however, is carried out in the open air, and with the aid of portable enclosures which shut in the whole trees; whereas here we would have to work inside houses in which the renoval of air is more difficult and without the expert operators, who have been trained in.

For this and other reasons we gave up the use of hydrocyanic acid prepared to work on sulphur dioxide, which has already been used successfully in the work against yellow-fever and with some success in the extermination of rats. Besides this it has the advantage of being inexpensive, safe in its use, a good parasiticide, slightly antiseptic and useful in the extinguishing of fires. LLOYD MILLS in Mexico advises its use against scorpions, but does not establish the technic nor the conditions under which it can be used effectively, if, in reality, he experimented with it.

Yet, some initial experiments in relatively large spaces and carried out without the necessary rigour even gave us the impression that scorpions were often able to resist sulphur dioxide. A strict handling of it, however, convinced us of its efficacy, at any rate under experimental conditions.

Naturally some of these experiments were made rather exaggeratedly, using superfluous doses, for it is known that the combustion of sulphur has a certain limit, calculated at 65 grammes per cubic metre of confined atmosphere.

Of the three better-known processes we only did not avail ourselves of liquid sulphur dioxide, since perhaps on account of its high price, is not to be found in the market. still, were it not for its high cost, the use of the liquefied gas ought to be very convenient, practical and efficacious besides being simple and elegant.

We consequently limited ourselves to the use of the CLAYTON furnace and to the current economical process of burning sulphur in an iron container, left inside the compartments to be fumigated, after having made them air-tight by the usual methods of public health workers.

EXPERIMENT N°. 1 (*)

Compartment of 7.350 m³. (in the Disinfection Office). Sulphur: app. 142 grammes per cubic metre. Animals placed in the higher part of the compartment: 2 scorpions, 2 *Triatoma*-larvæ, 2 cockroaches and 1 rat. At the end of 24 hours, when the compartment was opened all the animals were found dead.

EXPERIMENT N°. 2.

Compartment for the disinfection of carriages (Disinfection Office) of 48,731 cubic metres. About 100 grammes of sulphur per cubic metre: 6 % of saltpetre and 20 % of alcohol. Animals placed in the higher part of the compartment (**): 2 scorpions 2 cockroaches, 2 Triatomata, and 2 rats. All were dead after 24 hours.

EXPERIMENT N°. 3.

Basement store of the Institute in Bello Horizonte (52 cubic metres). 38 grammes of sulphur per cubic metre (1 % of saltpetre). Halfway up were placed: 2 scorpions, 2 cockroaches, and 2 rats. All of them dead after 24 hours. The substance employed was flowers of sulphur, which only burned in the ratio of 10 grammes per cubic metre.

EXPERIMENT N°. 4.

Same basement. Approx. 34 grammes per cubic metre. Approx. 1 % of nitre

---

(*) This series of experiments was carried out by the simple ignition of sulphur. The CLAYTON furnace only came into use later on.

(**) In most of the experiments the animals were kept in glassjars, shut with esttonwool. Only the rats were usually kept in small boxes with holes or wirenetting.

and 10 % of spirit. Animals placed on the ground: 2 scorpions, 2 *Triatoma*-larvæ, 2 adult Triatomata, 2 cockroaches and 2 rats. In spite of the damp weather all animals were dead after 24 hours.

———

These experiments might lead one to supposes that nothing is easier than the extermination of scorpions, triatomata, rats etc. We must state that the results obtained did not always agree, sometimes on account of the lack of training of the personnel, who ought to have some experience, sometimes on account of the deficiency of the material. The Sulphur, chiefly, frequently contains impurities such as sodium sulphate, sand etc., which lower its combustibility. A good quality of sulphur should be chosen and the sticks should be reduced to powder just before use. It is indispensable to add a little nitre or spirits to aid in its combustion. Finally the substances should never be used damp.

To give an idea of the inconstance of the first results we must mention that besides the four successful experiments, we also had four negative and 3 incomplete ones, so that out of a total of 11, only 36 % were entirely positive.

Having convinced ourselves that dampness was the chief cause of insuccess, and as we had to work in the rainy season we planned to use a preparation dry an rapidly combustible, made up of equal parts of sulphur in sticks and Chilian nitre (Sodium Nitrate).

We triturated these two substances, throroughly, mixed the, added a little water so as to make a fairly soft paste which we distributed in paper cones and dried by slight heating in an incubator (instead of an incubator any oven can be used). When they were quite dry, these blocks were taken out of the oven and freed of their paper: they were then ready for use.

By these means we obtained a convenient, cheap and simple product, which can be prepared and used by any one. In dry wether these cones can be kept for a long time, but in the rainy season they can be kept by plunging them into heated wax, in such a way as to allow the wax to cover them. Before use the wax must be scraped of.

At one time an imported product consisting of a sulphurous mixture with a wick, in little tins, could be obtained in the market. Were it not for its high price and for the fact that it cannot be found in the importation-houses, we should not hesitate to recommend it, as it satisfies all requirements.

In the absence of better means we advise the use of the sulphurous cones which yealded the following experimental results:

EXPERIMENT A 1.

Basement of the Institute (approx. 52 cubic metres). 8 cones, with a total weight of 1.267 grammes, i. e. approximately 24 grammes of the nitrate-sulphur mixture or 12 grammes of sulphur per cubic metre. Animals: 2 scorpions, 2 Triatoma-larvæ, 2 cockroaches and 2 rats (half of them on the ground, the other half above). After 24 hours all of them dead.

EXPERIMENT A 2.

In the same place 6 cones, with a total weight of 1.200 grammes (about 11 per cubic metre). Animals: 1 scorpion, 2 *Triatoma*-larvæ, 1 cockroach and 1 rat. Besides this, to prove the application of sulphur dioxide against fires, we lit a bonfire of wood in the same compartment. At the end of 24 hours, only half of it had burned. The animals were dead.

EXPERIMENT A 3.

In the same place, the animals at

one end inside a wire-screened cupboard the cones at the other end, 7m 67 away. 1 scorpion, 1 *Triatoma*-larvæ, 1 cockroach and 1 rat, placed on the ground ated after 24 hours. 1.350 grammes of mixture were comsumed (approximately 13 grammes of sulphur per cubic metre). A small rat that had previously disappeared was also found dead.

EXPERIMENT A 4.

Same conditions; time reduced from 24 to 12 hours. Besides the 2 scorpions, 1 *Triatoma*-larva, 1 cockroach, 1 lepisma and 1 adult rat we exposed cultures of the following bacilli; B. dysenteriæ FLEXNER and HISS-RUSSEL, choleræ, typhi, diphteriae, pyocyanicus, enteritidis and mallei. Only 3 cones were burnt (approx. 6 grammes per cubic metre). In spite of this hitch, due perhaps to the dampness of the air, all animals died within 12 hours. And although the experimental conditions were not rigourous the weak bactericide of sulphur dioxide was once more confirmed, for none of the cultures were sterilised, although they were of non spore-forming bacteria.

EXPERIMENT A 5.

Experiment carried out under the same conditions. 3 cones with a total weight of 494 grammes (approximately 4,50 per cubic metre). 7 hours afterwards there died 1 *Triatoma*-larva, 1 cockroach and 1 rat: the scorpion which was agonising, died shortly afterwards.

From this point, on, we tried to make experimental conditions more rigourous, placing the animals in points less easy of access to toxic agent, as happens under natural conditions. For this reason the results are more significant although sometimes incomplete.

EXPERIMENT A 6.

Basement storey of the Institute. 3 waxed cones, with a total weight of 1/2 kilogrammes (approx. 5 grammes per cubic metre). All the smaller animals were put as usual in glass-flaske stoppered with cotton-wool besides this some were wraped up in clothe others put inside the straw-stuffing of a mattess, 7 metres away from the burning sulphur.

At the end of 24 hours were found dead:

a)—All the animals that were left simply in flasks with cotton-wool stoppers, i. e. 1 scorpions, 2 fleas, 1 *Triatoma*-larva, 1 cockroach and 2 bugs;

b)—All the animals wrapped in clothes: 1 scorpion, 2 fleas, 1 *Triatoma*-larva, 1 cockroach and 2 bugs;

c)—Inside the mattress: 3 fleas and 4 bugs.

There survived: 1 rat (in a perforated wooden box) and 1 flea (inside the mattress).

EXPERIMENT A 7.

Same place: 7 waxed cones with a total weight of 1 kilogramme (approx. 9 1/2 grammes per cubic metre). Time 12 hours.

There died;

a)—In flasks with cotton-wool; 1 scorpion, 1 cockroach, 2 fleas, 2 bugs and 1 *Triatoma*-larva;

b)—Wrapped in a cloth; 1 scorpion, 1 cockroach, 2 fleas, 2 bugs and 1 *Triatoma*-larva;

c)—Inside mattress; 1 scorpion, 1 cockroach, 4 fleas, 4 bugs and o *Triatoma*-larva.

d)—In a perforated box; 1 of the rats.

There survived; 1 other rat, but it died on the following day.

EXPERIMENT A 8.

Same place: 5 waxed cones (with

a weight of 1 kilogramme (approx. 9 1/2 grammes of sulphur per cubic metre). Time: 6 hours.

Killed:

a)—In flasks with cotton-wool: 1 cockroach, 2 fleas and 2 bugs;

b)—Wrapped in a cloth: 1 cockroach;

c)—Inside mattress: 1 cockroach, 2 fleas and 2 bugs.

Alive:

2 rats, 1 in a box perforated and the other in a half-shut box.

The following broth cultures (recently dried): Bac: dysenteriæ FLEXNER and SHIGA and Bac. mallei. The latter resisted, the remainder were killed.

EXPERIMENT A 9.

Same place. Time: 3 hours, 580 grammes of the mixture refused to burn.

Killed:

a)—In the flasks with cotton-wool: 2 bugs;

b)—Wrapped in cloth: 1 cockroach and 2 bugs;

There survived;

a)—In a flask with cotton-wool; 1 cockroach;

b)—In a mattress: 1 cockroach and 2 bugs.

There also survived 2 rats and the following cultures; B. dyphteriæ typh. para-typh. B, dysenteriæ FLEXNER.

FUMIGATION of HOUSES.

The experimental results obtained convinced us that sulphur dioxide, at any rate in small compartments (approximately 50 cubic metres) and at the rate of 10 grammes per cubic metre would almost always kill scorpions, Triatomata, bugs, fleas, cockroaches and sometimes rats.

This rodent is the hardiest of the animals that infest human dwelling-places, and the scepticism of ROSENAU as regards their extinction is thus well confirmed.

For the ends we had in view it appeared to us that a double dose of sulphur and the maintainance of the fumigation during 24 hours might allow of some hope of satisfactory results.

Tanks to the courtesy of the Board of Health of the State, the necessary material and personnel were placed at our disposal; the Board entrusted the services to Dr. LEVY COELHO, to whom we render our most cordial thanks. Besides this an experienced chief of detachment was sent for from the National Public Health Department to instruct the men in the technic of fumigations, which consists more or less in the following:

The house which is about to undergo fumigation must be completely closed. Strips of airtight paper are stuck over all the cracks and holes. Metal object are given a coating of vaseline. Communication is established with the celling and attics after the roof has been covered with canvas sheets fixed to the side of the bulding. After an estimation of the volume of the space to be disinfected has been carried through, the suiphur is burned at the rate of 20 grammes per cubic metre, in numerous iron containers isolated from the ground by iron feet. Once all the sulphur is lit the men withdraw by the only door which has been left open and which is next closed and made airtight from outside. To start the combustion of sulphur a little alcohol or nitre or both are added to it.

For further information, we must refer to ROSENAU's Preventive Medicine and Hygiene in which the subject is given a full development.

We next give some of the results obtained in Bello Horizonte.

FUMIGATION Nº. 1.

House in the rua Guaycurús: bad

sanitary conditions. As controls we placed in different places: 1 scorpion, 1 rat, 2 cockroaches and 2 bugs. All of them were dead after 1 1/2 hours fumigation, as also a great number of cockroaches and bugs living there.

FUMIGATION Nº. 2.

House in the Prado Mineiro. Controls: 1 scorpion, 1 rat, 2 Triatomata, 2 cockroaches and 6 bugs eggs. An hour and a half afterwards the animals were still alive; but the sulphur did not burn entirely, perhaps owing to its inferior quality, for it left as residues blooks like pieces of stone.

The work was repeated with the same kind of sulphur, still with negative results. It was necessary to recommence work with sulphur obtained elsewhere to kill the animals. The house had 166 m³. of volume; 3.320 grammes of sulphur, 250 grs. of alcohol and 120 grs. of nitre (20 grammes of sulphur per cubic metre) were used.

FUMIGATION Nº. 3.

House in the rua Gonçalves Dias nº. 464, with 2 living-rooms, 6 bed-rooms, 1 corridor, kitchen and basement storey (688 cubic metres). Control: 1 scorpion, 1 rat, 2 cockroaches and a beetle. Sulphur; 20 grammes per cubic metre. After half an hour all the animals were dead.

Besides these many other fumigations were carried out, but as the notes refering to them got lost we omit to mention them.

As about this time the Board of Health obtained a CLAYTON furnace we resolved to try it also, more or less according to the technic employed by the National Public Health Department.

FUMIGATION WITH THE CLAYTON FURNACE.

FUMIGATION Nº. 1 A.

House in the rua Bernardo Guimarães with 672 cubic metres. Sulphur used: 9050 grammes (approx. 13 grammes per cubic metre); nitre 300 grammes; alcohol 400 cubic centimetres. At a distance of 17m20 from the nozzle of the transmission shaft of the furnace (which was brought in by a window)we placed 2 scorpions, 2 bugs, 2 cockroaches, 1 *Triatoma* and 1 rat. The furnace was foaded twice and worked during 3 hours and 25 minutes. At the end of this time we found dead; the scorpions, the bugs (*) and 1 cockroach. There survived; 1 cockroach, 1 *Triatoma* and 1 rat.

Next day the fumigation of the basement-storey was undertaken by the same process: Controls: 1 rat, placed at 9 metres distance from the transmitter, 1 cockroach and 1 *Triatoma* at 13 metres. At the end of 2 hours they were alive.

FUMIGATION 2 A.

House in the rua Gonçalves Dias, 344. Only one compartment was fumigated (157 cubic metres), with an expenditure of 3.140 grammes of sulphur (20 grammes per cubic metre), 150 grammes of nitre, 100 cubic centimetres of alcohol. Besides this the ground was disinfected with anosol solution. Controls: cockroaches, Triatomata and bugs placed at 4 metres from the trensmitting tube, half of them above, half of them below. The furnace worked during 2 hours, but the compartment was kept shut during 24 hours. All the animals died .

FUMIGATION 4. A.

Avenida Christovão Colombo nº. 344. Only the basement of this house, known to be infested by scorpions, was fumi-

(*) J. SILVADO, keen enthusiast and populariser of he CLAYTON furnace, has made experiments with fleas, bugs, flies, mosquitoes, ants rats and book-pests and obtained positive results.

gated. The basement was uninhabitable, dark, without any coating and with the walls full of holes. Volume: approx. 183 cubic me'res. Sulphur: 3680 grammes (approx. 20 grammes per cubic metre); nitre 180 grammes; alcohol: 200 cubic centimc'res. Controls: 1 *Triatoma,* inside a glass covered with a perforated paper, at 3,40 ms. from the transmission tube; 1 scorpion at 4,95 ms. After 25 hours both of them were dead, as were also a frog, a butterfly, a common spider and a tarantula that had been there spontaneously.

Besides these, the tenant told us that during the fumigation there appeared in the upper storey, which was not fumigated a scorpion, which appeared to have come from the base-board of rotten wood and five days later another also outside the basement.

For these facts we can only admit three hypotheses: a)—some of the scorpions had their dwelling-places outside the basement: b)—the basement was imperfectly sealed, so that the scorpions were enabled to leave it during the fumigation; c)—the fumigation was insufficient.

FUMIGATION 5. A.

Soldiers' Dormitory (227 cubic metres). Sulphur: 5540 grammes (20 grammes per cubic metre); nitre: 300 grammes; alcohol: 50 cubic centimetres. Controls: 1 *Triatoma* at 7,30 ms. from the trasmission tube, and 1 scorpion at 10,60 ms. At the end of 24 hours all were dead, as also a great number of flies and bugs.

———

We are the first to admit that the number of fumigations in naturally infested houses is small.

But it is not without effort that we have carried through what little has been done, and which can become a starting-point for future work on the subject. Besides, it is not without difficulty that one persuades the public to accept a new service which obliges the indifferent layman to abandon and surrender his house for a few hours to strangers who desorganise and may even damage it.

We have to admit, therefore, that some of the fumigations were incomplete, partly owing to the impossibility of lengthening the fumigation to 24 hours, which ought to be done as a general rule, partly owing to not being able to extend the fumigation to all compartments, which is always to be desired so as to obtain sure results. We were thus obliged to consult rather the convenience of the tenants than the necéssitiés of the work, which we *w*ere obliged to perform rapidly, between the principle meals of the day.

These and other contrelemps obliged us to limit the rigour of ours expériments; we were for instance unable to measure the gas injected by the CLAYTON furnace, which had it been possible, should have been done with the exactness of DIOGO DE FARIA's technic in the extermination of book-pests.

According to this illustrious Director of the Disinfecting Establishment of S. Paulo, the gas is effective under the folowing conditions: minimum quantity 12 %; this is obtained after five to seven hours by using 1 kilogramm per cubic metre (*). Besides this the gas must come from the higher part of the room which can be managed by a special device, of this author, who like JAYME SILVADO advocates the use of this gas against book-pests, who besides their hardiness resemble the scorpions in the fact that owing to their deep

---

(*) This is another of the CLAYTON furnaces advantages: it burns the sulphur in the open air, so that the only limit to the quantity consumed is the capacity of the furnace.

hiding-places they escape the action of the most subtle and penetrating gases.

We must however cali attention to the fact that these fumigations of books were always carried out in small compartments or small libraries, whereas we have to work in houses of 600 or more cubic metres and as quickly as possible. How much time would not be needed, what would it not cost to make these fumigations at the rate of 1 kilogramme per cubic metre and 12 % of sulphur dioxide at the highest point of a house with several storeys.

Another objection which we would also like to be the first to make. It refers to lack of certainty as to the results obtained. Several times we tried to ascertain the efficacy of our work, by searching for scorpions after the fumigation. But nothing is more difficult than to find scorpions without spolling a house, as the workmen who come upon them involuntarity while pulling down a wall well know.

The best would be the technic of LEOCADIO CHAVES (**) for demonstrating the action of sulphur dioxide on *Triatoma*-infested huts. This illustrious fellow-worker, after fumigating a straw-covered hut covered with canvas and paper. pulled it down completely and then counted the number of Triatomata found: he observed that 25 % had resisted.

As a similar process is inapplicable in cityhouses, we have to desist from using it, but we can hope, nevertheless, to have attained a similar percentage. It is also possible that the irritating action of the gas on scorpions should drive them from the fumigated houses. Besides this the evidence of the majority of tenants of fumigated houses is also in our favour for most of them observed the scorpions to disappear after fumigation.

Consequently taking into account on the one hand our experimental results and the other the defficiencies pointéd out besides other ones that authorities will discern in this unpretentious essay, we venture to bring forward the following conclusions:

a)—Sulphur Dioxide, on account of its toxic action, its diffusibility and harmlessness to those who handle it, is up to the present date the best substance for the fumigation of houses infested with scorpions;

b)—Wherever possible one or more CLAYTON furnaces should be used (according to the size of the furnace and the dimensions of the house); sulphur dioxide should be made use of at the rate of 12 % of gas at the highest point (*) as in pointed ont by DIOGO DE FARIA;

c)—If the furnaces cannot be obtained, the combustion of sulphur in iron containers must be made use of; the minimum quantity of sulphur is 20 grammes per cubic metre and the iron containers must be profusely distributed over the different compartments;

d)—Sulphur cones can me made use of, at the same rate; any kind of pans, basine, tins etc. can be used but it is always advisable to isolate them from the floor;

e)—Whenever possible the fumigation should comprise the whole house and should last for 24 hours;

f)—When it is impossible to make the fumigation last so long, it should be repeated some days afterwards;

g)—The house must be made rigourously air-tight;

h)—Fumigation is an urgent step and the only one of rapid effect in the

(**) Verbal communication.

(*) Sulphur Dioxide is heavier than air.

struggle against scorpions that have overriden a house;

i)—It has the advantage of aiding in the suppression of other domestic pests, such as bugs, fleas, spiders, cockroaches, flies, mosquitoes, rats, book-pests etc.

j)—However efficacious the fumigation may have been, it can only be considered a temporary measure, since nothing prevents scorpions from returning to infest the house once its effects, which are short-lasting, are over.

THE FREEING OF FURNITURE FROM SCORPIONS.

Once the drawbacks of sulphur dioxide, which attacks metals, gilding, delicate and coloured tissues, specially in damp weather, are known, it will be necessary to avail oneself of other substances to extinguish the scorpions infesting furniture, sometimes of great value.

In this case the use of xylol is indicated, at the rate of about 350 cubic centimetres per cubic metre. For this purpose the most convenient is to imbive several balls of cotton-wool with xylol and to place them in small cantainers. These are then left in different parts of the furniture, which must then be made airtight with gummed paper, for the vapours are very diffusible and troublesome.

We have tested this process on drawers and shelves and have obtained good results not only in the cases of scorpions but also with cockroaches, silver-fish (lepisma), spiders and flies. At the end of 25 hours all these animals are dead. The only one that sometimes survives is the *Triatoma,* specially in the form of nymphae. But even this insect usually becomes mortally poisoned and dies within a few days. But to be on the safe side it is advisable to make the fumigagation last 48 hours.

This is an underniably expensive process, and has consequently few practical applications. But there are cases in which this is the only process of which we can avail ourselves. Scorpions are sometimes found in the most unforeseen places: we need only mention that we once came upon a female scorpion with all her young calmly hidden away inside a piano.

It is in this and similar cases that our process can be made use of, for without the disadvantages of sulphur dioxis it must be efficacious against the pests that attack books, such as ants, beetles *(Anobium)* silver-fish (lepisma), cockroaches, spiders, ants etc.

To arrive, at definite results it would be necessary to undertake new experiments and observations; and in the event of their turning out favourably it would be advisable to repeat the fumigations after 15 days, not only to garantee the disinfestation of the furniture but to make up for the possible survival of any eggs. And if the results on the parasites of libraries should really prove useful it might be worth while to vulgarise the process in spite of it high cost, for it would then be another element in the struggle against the hardy and tenacious insect-pests.

II

HOUSES UNSUITABLE FOR INFECTATION BY SCORPIONS.

Starting out from the fields, the dominant species of the central region of the State of Minas Geraes, specially *Tityus serrulatus,* find in most human dwelling-places, even in the cities, the conditions necessary to life: deep hiding-places, darkness, quietness and food.

They consequently prefer dark, low, uninhabited, barewalled, basements. Any little crack suits them; the space left between two bricks or two stones, any

chink under the beams, in fact, any of those little nooks found in badly-finished buildings, which unfortunately are only too common.

In the cold season all goes relatively well: it is rare to see a scorpion outside its hiding-place. But once the hibernation period is over, about the time of the first September or October rains, no sooner has dusk fallen, the scorpions begin to emerge silently to exercise all their functions. Then, as a rule, they will leave their haunts in the basement, climb up the walls, go through between the boards of the flooling bekind somme shrunken or rotten base-board and make their way imperceptibly into inhabited compartments.

The best way to avoid accidents due to scorpions is to build houses unsuited for housing these animals. Naturally this task belongs to sanitary architecture and engineering, which can lay down rules with this object after consulting the data furnished by naturalists. But while this ideal is not attained we think acceptable the following rules, some of which are taken from the Regulations of the National Department for Public Health and from the Sanitary Code of the State of São Paulo:

1.—All the surface of soil occupied by buildings shall be covered with a continuous dampness-isolating layer that may protect it from the invasion of rats. This layer shall be one of the following:

a) concrete cement of 0,10 ms. thickness and of at least 1:3:6.

b) layer of asphalt of 2 centimetres, on a basis of stone with cement mortar of at least 0,10 ms. thickness;

c) glazed tiles on a layer of stone with cement mortar of at least 0,10 ms. thickness;

2.—The walls inside the basement storey shall have an impermeable and resistant coating (cement for instance) of at least 0,30 ms. height and from this height upwards they shall be carefully plastered and white washed, so that there shall be no crevices, however small;

3.—Basement storeys shall not have less than 1,50 ms. height;

4.—Clay shall not be used for mortars and plasters of buildings;

5.—The extremities of rafters and boards, as well as the parts of door-frames and window-frames in touch with the walls and any other wood-work entirely exposed to the air shall be coated with pitch;

6.—Base boards may only be of cement or tiles;

7.—Ornamental wood-work (friezes, picture-rails, etc.) are not advised;

8.—All the boards of the flooring shall be perflectly joined;

9.—Empty spaces between flooring and ceiling shall be considerd unsanitary;

10:—All compartments destined for kitchens, pantries, scelleries, bath-rooms and water-closet shall have their was covered with glazes or ordinary tiles up to a height of 1,50 ms. and the ground with tiles joined together with cement. In the country and in workmen's quarters cement may be employed, provided it contain no cracks;

11.—Houses with walls not plastered, whitewashed or painted inside and outside shall not be used for living in;

12.—The walls above the ceiling shall also be whitewashed on the inside;

13.—Walls of clay adobe shall not be permitted; nor shall thatched roofs be allowed;

14.—Round all buildings, as well as in court and areas there shall be an impermeable and resistent path of at least 1 metre width;

15.—Walls of clay, unplastered stone or brick shall not be permitted;

16.—Heaps of fire-wood shall not be permitted in or about the houses; these heaps shall be made in sheds wi-

thout walls away from the house and more or less in the chicken yard;

17.—Ovens of clay, termit heaps, or even of unplastered brick shall not be advised;

18.—For a recently built or rebuilt house to be considered habitable it shall be examined by the competent authority who shall ascertain whether these measures have been carried out and sugges any others that may be advisable.

These measures, here indicated more or less abbreviatedly, allied to the recognised rules of building and of domestic hygiene (so often neglected) might be included in municipal laws and by-laws of all the towns and villages where scorpions are common, which are subject to CHAGAS's disease, epidemics of plague, etc..

We must consequently appeal to the public authorities of our country, not only to the Presidents and Governors of States but above all to Municipal Chambers, to study and criticise our ideas, submitting to the opinion of the authorities on the subject, that is, to biologists, public health workers and sanitary engineers. And should they perchance deserve the honour of being sanctioned, let them be put into practice, that millions of our countrymen may not continue to live in promiscuity with poisonous arachnoids, with insect-transmitters of incurable diseases, with rats the harbingers of pest-bacilli, not to mention other domestic pests that hygiene condemns and cleanliness repels.

III

COMPLEMENTARY STEPS.

Besides fumigation, which is the most urgent, step, enabling a decrease in numbers of the scorpions in an infested house; besides the works advised in the preceding chapter and which are the best guarateet against an invasion by scorpions, there are other helpful measures which must be taken into consideration.

In the first place, it is evident that even in a scorpion-proof house, no one must forget the ordinary rules of domestic hygiene, the moreso in a tropical climate like ours. Among these we must specially recommend the frequnt scrubbing of floors with antiseptic and at the same time parasiticide solution such as lysol at 4 %, creolin at 5 %, carbolic acid at 5 % etc. These solutions must be made with warm water at least heated to 50°C., for this augments their bactericide and parasiticide power. Besides this the sweeping and clea-of the whole house, underneath, behind and inside the furniture, the systematic destruction of spiders, cockroaches etc., the favourite prey of scorpions, must not be omitted.

These indications are so evident however that w ewill exempt ourselves from underlining their necessity.

We must not cease however to advise the utmost care in avoiding the reinfestation of houses. This is specially liable to happen if special care is not taken with fire-wood, building-materials anything else coming from the fields. Fire-wood is the worst transporter of scorpions, that by its agency find a way into our houses; and when in these they do not find the desired hiding place they may do some mischief.

To avoid the entrance of these undesirable the ideal would be to build in the grounds of each house a desinfection chamber where the fire-wood would be fumigated before coming into use.

But as this would only be possible in exceptional cases, we put among the instructions for buildes a clause 16, whose explanation is found in the following lines.

SCORPION-DESTROYING ANIMALS.

VITAL BRAZIL, the remarkable organiser of the campaign against snakes in our country, believes in the effective aid of *Oxyrhopus cloelia* (mussurana) an inoffensive snake that feeds on other snakes including poisonous ones. F. IGLESIAS recommends *Conepatus chilensis* (cangambá) a small mammal of our continent that has the property of emitting a nauseating and toxic fluid. Finally the great authority A. CALMETTE adopts V. BRAZIL's ideas and cites other interesting cases of snake-eating snakes.

One might also expect to find animals immune to scorpions-poison and able to eat them with impunity.

Perusing the limited litterature we were able to obtain, we found in the excelient work by WILLIAM WILSON a list of Egyptian animals immune to scorpion-poison. Of these animals, 5 are mammals: *Gerbilus pyramidum, Jaculus jaculus, Vulpes zerda, Ictonix lybica* and *Erinaceus auritus;* 1 reptile: *Veranus cinereus*. This author does not mention any scorpion-eating propensities: he merely believe that the resistance of these animals must have been acquired in the desert, where these speciés livé in contact with the scorpions the most frequent of which are *Buthus quinquestriatus,* the common and noxious, *Prionurus citrinus* and *Buthus maurus.*

CHARLES TODD studying in the same region, observed the marked degree of immunity of a rat that is commonly found in the natives dwelling-places, *Accomys cahirinus*. But he does not attribute them any scorpion-destroying properties any more than to *Mus musculus* and *Mus alexandrinus,* which are sensitive to the poison.

In his magnificent thesis HEITOR MAURANO, resumes this question in the following way: «Vertebrates, molluscs and arthropods are the most sensitive...» and «according to LAFFUIE, the animals lowest in the zoologic scale appear to be completely indifferent to the poison».

Speaking of immune animals he remarks that «the cat is resistant, so much so that it is very fond of chosing scorpions». He also gives us a very curious observation, illustrated by a drawing of his own, in which a common rat defends itself form a scorpion, pinning it down with its fore-paws and extirpating with one bite its poison-vesicle.

As this is the biggest and most important national work on the subject, we naturally tried to make use of the observations and experiments of H. MAURANO for our own ends.

As regards cats, we only once saw a cat tackling a scorpion. We are not aware of their having any special predilection for scorpions, inasmuch as these do not offer them a flashy morsel like rats and birds which are undoubtebly their favourite food. One must not rely much on cats as an element in the struggle against scorpions.

As for rats even if they were very efficient against scorpions, which is not the case under natural conditions, no one would chose them as an ally of man, even against a mutual enemy.

Now, many old inhabitants of Bello Horizonte tell us that ordinary fowls kill and eat scorpions that pass within their reach. M. GUYON however, denyies any immunity against scorpion poison to dogs and rabbits, among mammals, and chickens and pigeons among birds. Speaking of a different species *(Androctonus funestus)* to our own, he remarks about these birds that they «*succombent fréquemment et rapidement à sa piqûre voire même à celle d'Androctonus occitanus*».

Finally H. MAURANO, in spite of having observed «certain birds, chiefly gallinaceous ones, eat a great number of scorpions with impunity» is the first

to acknowledge that «birds also frequently succumb to scorpion poison».

In the face of these rather conflicting facts we resolved to mark a few experiments, which showed with *w*hat keenness a chicken will eat scorpions: one of ours take eight live ones *(Tityus serrulatus)* and would have accepted more if we had them to give her. Young chickens are equally able to eat scorpions with impunity as we were able to observe when we gave a 5 months old a live *Tityus serrulatus*. This chick, although it had been well-fed, ate it with such avidity, that it was obliged to regurgitate it before swallowing it definitely.

To complete these experiments which had already led us to believe in the immunity of chickens, which are able to eat live scorpions with poison at the tip of their sting, we asked Dr. OCTAVIO MAGALHÃES, to whom it belongs to study the physiological parts, to study the resistance of this fowl. According to his results it is fairly marked.

This said, we cannot hesitate a moment in affirming that the chicken is the scorpions-destroyer par excellence, and as such it ought to be made an excellent aid in the struggle against scorpions.

But, in what way should chickens be made use of?

Were it possible to instal chickens inside our dwelling-houses, the at leastin overiden basement-floors the problem would be solved. But no hyginist could approve of a similar measure.

But since we know that the greater part of scorpions is brought in by firewood, it is evident that this should be within reach of the poultry, as clause 16 of our instructions advises. And these birds with the avidity and pertinacity with which they peck at everything would thus defend our homes.

We must also suppose that in small country houses where the poultry is loose round the house scorpions must be very rare, because the chickens eat them before they are able to enter the houses.

Notwithistanding the efficient help which poultry may furnish, the other means of defense and precautions must not be relinquished, for the scorpion is an animal subtle, mysterious, nocturnal, which can easily elude man, escaping the means of combat of which he can dispose.

CONCLUSIONS:

In view of the facts, experiments, and arguments here exposed, the following practical conclusions appear to us acceptable.

1º—A plan for a struggle against scorpions is perfectly feasible, especially against the ones of the genus *Tityus* that inhabit certain regions of Central Brasil, invade human dwelling places and provoke accidents which in children may be serious:

2º.—This plan for the struggle consist in three kinds of measures which complete one another:

a) fumigation of infested houses;

b) construction of houses unfit for scorpions to live in:

c) complementary measures.

3º.—In towns that have a well-organised sanitary service no one should move house without first requiring a fumigation of the new house;

4º.—In the towns that have no Public Board, the municipal chambers should create at least a contingent of 3 or 4 men who, in the same manner as those that are in some places employed for killing ants, would be charged with carrying on these expurgations, according to the instructions handed out by the Health Boards of the States:

5º.—Fumigation is a measure of urgency for persecuting scorpions and other domestic pests;

6º.—However efficient a fumigation may be it cannot be considered a radi-

cal means of prophylaxis, since once it is over all the scorpions and all the other domestic pest will return to infest the house again unless it has suffered a radical transformation;

7º.—The best garantee against scorpions and other undesirable guest is the building of houses in such a way as to make them inadequate for the life of these animals;

8º.—All municipal chambers should establish laws and by-laws referring to the building and rebuilding so as to avoid the construction of houses in disagreement with the rules we have suggestet:

9º.—At any rate the in tropical climates, subject to epidemics and endemics such as the plague, CARLOS CHAGAS'disease etc, such rules of construction systematically adopte would, also bring real advantages in the propylaxis of various disease and the extinction of divers parasites;

10º.—In the wealth towns the buying of scorpions, at any rate of the ones caught within the boundaries of the town might be advised, so as to reduce their number and to direct them to the Institutes that undertake the preparation of scorpion antivenin, the only efficatious medical treatment for the poisoning;

11º.—In the zones infested with scorpions extensive poultry farming as should be encouraged poultry, intelligently made use of is able to render services to man in anti-scorpionic campaign:

12º.—A more intimate cooperations between zoologist, hygiene-workers, sanitary engineers and architects with the object of elaborating jointly, detailed projects for houses destined to tropical climates.

Bello Horizonte, May 3rd 1922.

Explanation of Plates

Figure 1

Sulphur cone as it begins to burn in an iron receptacle suitable for fumigations.

Figure 2

Basement storey of a house infested with scorpions *(Tityus serrulatus)*. Photograph taken with magnesium light.

Figure 3

Basement storey of a house from which the scorpions disappeared after it had been improved according to our indications. (Photograph with magnesium light).

Figure 4

Snapshot of a chicken devouring a scorpion.