with dibenzanthracene after 19 min. 34 sec. ± 3 min. 35 sec.

It is evident that the benzpyrene has the strongest photodynamic effect; after this comes methylcholanthrene, and dibenzanthracene is last. Roughly speaking, methylcholanthrene has a half, dibenzanthracene a third, as strong photodynamic effect as benzpyrene. The benzpyrene-treated larvæ perished with a sixth of the ultra-violet radiation required for the controls, the methyl-cholanthrene-treated larvæ with a third, and the dibenzanthracene-treated larvæ with half as much.

G. Matoltsy
Gy. Fábián

Biological Research Institute,
Tihany.
Oct. 26.

[1] Mottram and Doniach, *Nature*, **140**, 933 (1937).

Action of Heparin on the Venom of *Echis carinatus*

Ahuja *et al.*[1] have presented experimental evidence to show that heparin is capable of neutralizing the blood-coagulant action of Russell's viper venom *in vitro* and of counteracting to a considerable extent the toxicity of this venom *in vivo*. Further studies were undertaken to find out if heparin exerted a similar action on the venom of the other common Indian viper, *Echis carinatus*. The venom used in the experiments was obtained through the courtesy of the director of the Haffkine Institute, Bombay. It was a well-dried sample composed of a mixture of the venom extracted from several *Echis* vipers.

Heparin was a solution in physiological saline of the sodium salt of heparin of a strength of 10 mgm. per ml., each mgm. representing 110 Toronto units approximately.

Table 1. Action on blood-coagulant activity of *Echis* venom *in vitro*

Echis venom (mgm.)	Heparin (mgm.)	Sheep blood (ml.)	Result
0·1	Nil	1·0	Clot 36 sec.
0·1	1·0	1·0	Clot 2 min. 35 sec.
0·01	Nil	1·0	Clot 42 sec.
0·01	1·0	1·0	Clot 8 min. 25 sec.
0·001	Nil	1·0	Clot 2 min. 15 sec.
0·001	1·0	1·0	Clot 90 min.
0·0001	Nil	1·0	Clot 4 min. 55 sec.
0·0001	1·0	1·0	No clot 8 hr.; clot 24 hr.
Nil	Nil	1·0	Clot 8 min.
Nil	1·0	1·0	No clot 24 hr.

It will be seen from Table 1 that (*a*) 1·0 mgm. of heparin in the presence of 0·01 mgm. of *Echis* venom can prolong the clotting time of blood from 42 sec. to 8 min. 25 sec., which is the normal clotting time of sheep blood; and (*b*) 1 mgm. of heparin is unable to prevent the coagulant action of even 0·0001 mgm. of *Echis* venom, although it can prolong the clotting time from 4 min. 55 sec. to 8 hours.

Table 2. Action on toxicity of *Echis* venom *in vivo*
Echis venom and heparin mixed, incubated at 37° C. for 30 minutes and the mixture given intravenously to rabbits

Rabbit weight (gm.)	Venom (mgm.)	No. of lethal doses injected	Heparin (mgm.)	Result
1275	0·02	2	Nil	Died 1 min.
1650	0·01	1	Nil	Died 19 min.
1875	0·01	1	Nil	Died 15 min.
1725	0·005	½	Nil	Survived
1800	0·01	1	5	Survived
1885	0·1	10	7	Survived
1480	0·2	20	15	Survived
1500	0·2	20	15	Survived
1650	0·3	30	30	Died 10 min.
1695	0·3	30	50	Died 3½ hr.

The minimum lethal dose of *Echis* venom for rabbits was found to be 0·01 mgm. This dose consistently killed the animals in 15–20 min. when given intravenously. When *Echis* venom was mixed with heparin and given intravenously, the animals did not die even though the dose of venom injected was twenty times the lethal dose. With the dose of venom increased to 30 times the lethal dose, even 50 mgm. of heparin could not save the animal.

In the light of our previous studies on the action of heparin on the venom of *V. russellii*, in which it was shown that one part by weight of heparin could effectively counteract *in vivo* the lethal action of at least an equivalent amount of Russell's viper venom, the results obtained with *Echis* venom show that: (1) comparatively a much larger quantity of heparin is required to counteract the toxic effect of *Echis* venom under experimental conditions *in vivo*; (2) weight for weight, *Echis* venom is a much more powerful blood coagulant than the venom of *V. russellii*; and (3) when the dose of *Echis* venom injected is increased beyond certain limits, namely, twenty times the minimum lethal dose, some of the animals show paralysis of the limbs and gradually increasing respiratory failure as against the usual convulsive seizures seen with smaller doses. It is possible that with higher doses, toxic fractions other than the one responsible for intravascular coagulation, for example, neurotoxic or hæmorrhagic fractions, increase from a sub-lethal to a lethal level. Heparin is obviously ineffective against these other fractions.

In view of the fact that *Echis* is a small snake which seldom gives more than one or two lethal doses in a full bite in man, and that, too, subcutaneously, these results are sufficiently encouraging to warrant the therapeutic trial of heparin in cases of *Echis* bite, particularly when specific antivenene is not available.

We are indebted to Messrs. Eli Lilly and Co. for the supply of heparin used in these experiments.

M. L. Ahuja
N. Veeraraghavan
I. G. K. Menon

Pasteur Institute of Southern India,
Coonoor.
Oct. 14.

[1] Ahuja, M. L., Brooks, A. G., Veeraraghavan, N., and Menon, I. G. K., *Ind. J. Med. Res.*, **34**, No. 2 (Oct. 1946).

Action of Mustard Gas on the Bone Marrow

In their article on "Biochemical Research on Chemical Warfare Agents", Dixon and Needham[1] refer to the work of Wormall and his co-workers[2] on the distribution of mustard gas (H.) in the organs of rabbits which have been injected with a preparation of H. containing radioactive sulphur. It was found that the bone marrow contained only about one twentieth of the amount detected in the kidneys and lungs. Dixon and Needham go on to say: "It is surprising that marrow, the tissue most damaged, had the lowest H. content, while the two tissues with by far the highest H. content are practically undamaged by H. poisoning". They then develop a theory to account for these findings.

This interpretation, however, ignores the finding that mustard gas exercises drastic effects on the nucleus. It is capable of breaking chromosomes and thus interferes with mitosis or inhibits it altogether[2–4].