"The Comparative Chemistry of the Suprarenal Capsules." By B. MOORE, M.A., Sharpey Research Scholar and Assistant in Physiology, University College, London, and SWALE VINCENT, M.B. (Lond.), British Medical Association Research Scholar. Communicated by Professor SCHÄFER, F.R.S. Received November 23,—Read December 16, 1897.

(From the Physiological Laboratory of University College, London.)

It has been fairly well established that the paired suprarenal bodies in connection with the sympathetic nervous system of Elasmobranch fishes correspond structurally and functionally to the medulla of mammalian suprarenal capsules.* There is also considerable evidence in favour of the homology of the inter-renal body of Elasmobranchs (and of the suprarenal bodies of Teleosts and Ganoids) with the cortex of mammalian suprarenals. This evidence in the case of the cortical glands is chiefly morphological and histological, the experimental results being purely negative.*

The paired suprarenal bodies of Elasmobranchs have been shown to produce the characteristic rise of blood-pressure when an extract of them is injected intravenously into a living mammal, or persistent contraction of arterioles when an extract is perfused through the blood-vessels of a pithed frog.† It has further been demonstrated that a subcutaneous injection of an extract from these same bodies will produce fatal results in mice, just in the same way as if prepared from the medulla of mammalian supra-renals.‡ The inter-renal of Elasmobranchs and the known suprarenals of Teleosts have no physiological action either administered intravenously or subcutaneously,†‡ thus rendering it probable that they consist of cortical material only, as had appeared from their histology.*

Up to the present the comparative chemistry of the subject has not been investigated.

It has been shown that the medulla of mammalian suprarenal contains a substance exhibiting well-marked colour reactions.§ Like the physiologically active substance of the medulla, this chromogen has not yet been isolated, but it always occurs closely associated with

* Collinge and Vincent, 'Anat. Anz.,' vol. 12, Nos. 9 and 10, 1896; Vincent, 'Birm. Nat. Hist. and Phil. Soc. Proc.,' 1896, vol. 10, Part I; and 'Zool. Soc. Lond. Trans.,' vol, 14, Part III, 1897.

† Swale Vincent, 'Anat. Anz.,' vol. 13, Nos. 1 and 2, 1897, and 'Roy. Soc. Proc.,' vol. 61, 1897, p. 64; also 'Physiol. Soc. Proc.,' Mar. 20, 1897.

‡ 'Roy. Soc. Proc. (in the press).

§ Vulpian, 'Compt. Rend.,' vol. 43, 1856; *ibid.*, vol. 44, 1857; Virchow, in 'Virchow's Archiv.,' vol. 12, 1857; Arnold, *ibid.*, vol. 35, 1866; Krukenberg, *ibid.*, vol. 101, 1885.

the active material.* When active suprarenal material is subjected to the action of strong alcohol (98 per cent.) for seven to ten days, the active material becomes destroyed, as shown by the physiological test of intravenous injection, but the chromogen is unaffected, and continues to give the usual colour tests in a characteristic fashion.† Hence the two substances are not identical, but their close association suggests the probability that the active material has a very complex molecule (for only such a molecule would be destroyed by prolonged contact with alcohol), and that the group giving the colour reactions forms an integral part of this molecule, and is not broken up in the decomposition.‡

The colour reactions referred to above are common to all ortho-dihydroxy-benzene derivatives, and are briefly as follows :—

1. Addition of various oxidising agents causes a rose-red coloration. This can be produced by addition of bromine-, or iodine-water, or solution of hydrogen peroxide, or alkalis.§

2. Addition of ferric chloride to a neutral solution causes a deep green colour.

3. Certain metallic salts are precipitated and then reduced, *e.g.*, addition of $AgNO_3$ causes a white precipitate which rapidly becomes black from reduction, especially on warming. Similarly, phosphomolybdic acid produces a yellowish precipitate, which, as well as the yellow solution, rapidly turns green.

4. Addition of potassium chromate causes a deep brown colour, probably due to an admixture of the colour of the chromate with the products of oxidation of the chromogen.

Although there is no purely chemical test known which indicates the presence of the physiologically active material, these colour tests make it easy to demonstrate with certainty the presence of the chromogen. Now, as the chromogen and the active material are closely associated in the mammalian medulla, and, as it has further been shown that the paired bodies of Elasmobranchs contain the active material,|| it appeared to us of importance to determine whether the chromogen was also present in these structures. Accordingly, the following experiment was performed.

* Moore, 'Physiol. Soc. Proc.,' March, 1894 ('Journ. of Physiol.,' vol. 17, 1895, p. 14).

† This applies not only to mammalian medulla but also to the medullary suprarenals of Elasmobranch fishes (*vide* Vincent, 'Roy. Soc. Proc.' vol. 61, 1897, p. 64).

‡ Moore, 'Journ. of Physiol.,' vol. 21, 1897, p. 382.

§ This rose-red colour produced by alkalis immediately and completely disappears on making acid again, and once more returns on making alkaline; the change in colour may be repeated as often as is desired. It is also intensified if the suprarenal extract has previously been boiled in acid solution.

|| Vincent, *loc. cit.*

Thirteen perfectly fresh, medium-sized specimens of *Scyllium canicula* were dissected, and the paired suprarenals and the inter-renals carefully removed. The paired bodies were all picked out first, and then knife and forceps were changed for the removal of the inter-renal, so as to avoid the possibility of contamination by their means.

The paired suprarenal bodies were found to weigh in a moist state 0·7 gram, while the inter-renals obtained amounted to 0·33 gram.

Each of these was boiled in water for a short time, and allowed to stand for about a quarter of an hour to allow time for complete extraction. The decoctions were made up to a strength of 10 per cent. of the moist glands. After filtering, the extract obtained from the paired suprarenals was of a pale brownish-pink colour with a distinct fluorescence, while that from the inter-renals was much paler, being light yellow and devoid of fluorescence.

On testing these two solutions, it was found that:—

1. Ferric chloride gave a deep green coloration with the decoction from the paired suprarenals, while no change was produced in the case of the inter-renal extract.

2. Iodine water, when added to the solution obtained from the paired bodies, produced a decided pink colour, while it effected no change in the tint of the inter-renal fluid.

3. Hydrogen peroxide gave a pink coloration in the case of the paired bodies only.

4. Caustic potash gave with the paired suprarenal extract an immediate dirty brown colour, but if a drop of weak hydrochloric acid had been previously added, a pink coloration immediately ensued. This reagent gave no effect in the case of the inter-renal.

5. Potassium chromate produced a deep brown coloration with the decoction obtained from the paired bodies,* but gave no change in that from the inter-renal gland.

6. Silver nitrate gave a white precipitate which immediately became black with the decoction of the paired bodies, but no effect with that of the inter-renals.

7. Phospho-molybdic acid gave, in the case of the paired bodies, a yellow precipitate which, as well as the solution, turned green from reduction, gradually in the cold, more rapidly on warming. This reaction was not obtained in the case of the inter-renals.

These reactions prove conclusively that a chromogen having the same chemical nature as that found in mammalian medulla is found in the paired segmental suprarenal bodies of Elasmobranch fishes.

* This deep brown colour with salts of chromic acid has been employed to display the medullary glands for purposes of dissection. It is a convenient means of picking out medulla from cortex in those animals in which the two are united into one organ.

It has been concluded from histological and physiological evidence that the suprarenal bodies of Teleostean fishes consist solely of cortex.* The physiologically active material is wanting, as in cortical substance elsewhere, and it would be interesting to determine the presence or absence of the chromogen. Unfortunately we have been unable so far to obtain sufficient material for chemical examination. The same remarks apply to the suprarenal bodies of the Ganoids.

For the purpose of comparison, we have chemically tested an extract made from the suprarenal glands of the frog. Six good-sized animals were killed and the suprarenals snipped off from the kidney with scissors. Although there was a considerable admixture of kidney substance with the material thus obtained, the weight in a moist state only amounted to 0·13 gram. This was treated in the way described above for the Elasmobranch material, and gave the chromogen reactions in a perfectly definite manner.

"Memoir on the Integration of Partial Differential Equations of the Second Order in Three Independent Variables, when an Intermediary Integral does not exist in general." By A. R. FORSYTH, F.R.S., Sadlerian Professor in the University of Cambridge. Received November 23,—Read December 16, 1897.

(Abstract.)

The general feature of most of the methods of integration of any partial differential equation is the construction of an appropriate subsidiary system and the establishment of the proper relations between integrals of this system and the solution of the original equation. Methods, which in this sense may be called complete, are possessed for partial differential equations of the first order in one dependent variable and any number of independent variables; for certain classes of equations of the first order in two independent variables and a number of dependent variables; and for equations of the second (and higher) orders in one dependent and two independent variables. The present memoir discusses the theory of partial differential equations of the second order in one dependent and three independent variables; and the method adopted is seen, without difficulty, to be applicable to equations which involve more than three independent variables and which can be of order higher than the second. The reason why equations of the type considered are taken to be such as do not possess an intermediary integral, that is, a

* Vincent, *loc. cit.*