CCCXXVI.—10-*Chloro*-5 : 10-*dihydrophenarsazine and its Derivatives. Part XV. Monoacyl Derivatives.*

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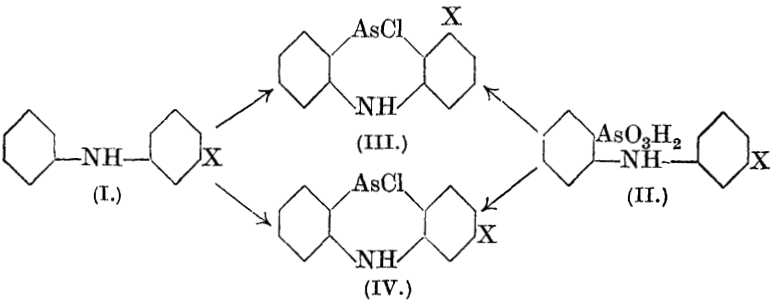
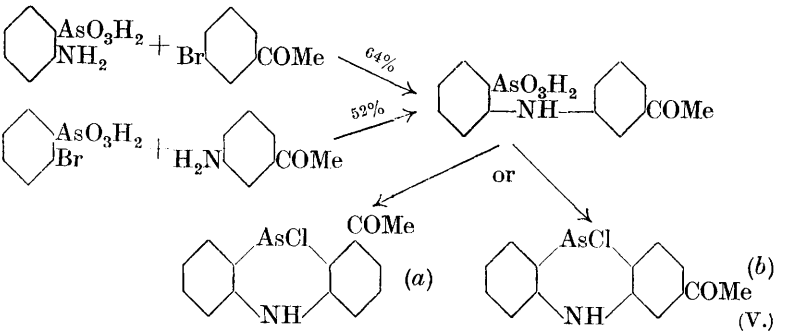
IT has been emphasised in previous papers of this series that if substituted diphenylamines of type (I) undergo condensation with arsenious chloride and when substituted diphenylamine-6′-arsonic acids of type (II) undergo ring closure accompanied by reduction in hydrochloric acid solution, the production of two isomeric monosubstituted 10-chloro-5 : 10-dihydrophenarsazines (III) and (IV) is



theoretically possible. Up to the present, the product obtained in either of the above ways has always been homogeneous (J., 1926,

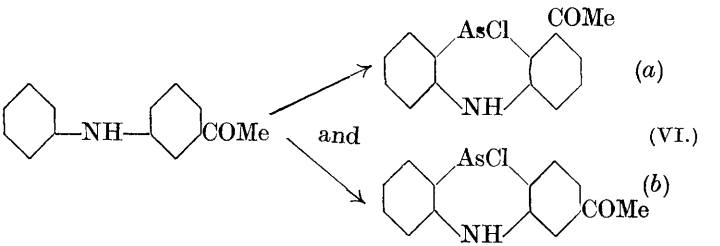
2242; 1927, 1229, 2499; 1928, 2204; 1929, 2743; 1930, 1124, 1622; this vol., p. 294) and there may be considerable difficulties in orienting the homogeneous product in particular cases (J., 1929, 767, 1473).

A homogeneous monoacetyl derivative of 10-chloro-5 : 10-dihydrophenarsazine (V) has now been obtained as indicated :



and, further, the substituted 10-chloro-5 : 10-dihydrophenarsazines obtained by condensing *o*-aminophenylarsonic acid with *m*-bromopropiophenone and *m*-bromo-*n*-butyrophenone (Elson, Gibson, and Johnson, J., 1930, 1128) respectively and effecting ring closure under the usual conditions were also homogeneous. The homogeneous product (V) has m. p. 268—270° (decomp.) and gives a blue-purple colour in concentrated sulphuric acid.

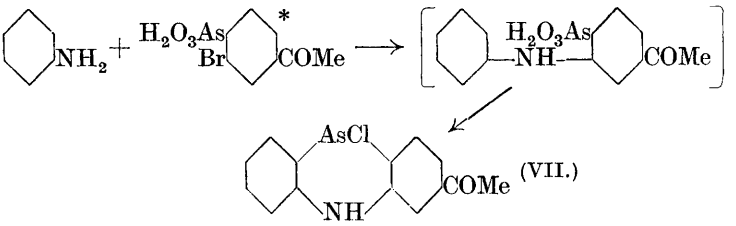
On the other hand, the product of the condensation of m-*acetyldiphenylamine* with arsenious chloride is not homogeneous and two products (VI*a*) and (VI*b*) have been obtained. These are iso-



meric. The less soluble product [labelled (VI*a*)] has m. p. 280° (decomp.); it was readily separated and obtained pure. The other, m. p. 250° (decomp.), may not have been obtained completely free from (VI*a*). The compound (VI*a*) gave a bright red colour in sulphuric acid, while (VI*b*) gave a red-purple colour in the same conditions.

10-*Chloro*-3-*acetyl*-5 : 10-*dihydrophenarsazine* (VII) has been

synthesised as shown, the intermediate 3-acetyldiphenylamine-6-arsonic acid not being isolated :



(VII.)

This compound (VII) has m. p. 270° (decomp.) and gives the same blue-purple colour with concentrated sulphuric acid as compound (V) does and the mixture of these two pure substances does not show any alteration of the melting-decomposition point. Compound (V) is therefore 10-chloro-3-acetyl-5 : 10-dihydrophenarsazine (V*b*). Compound (VI*a*) on admixture with the synthesised 10-chloro-3-acetyl-5 : 10-dihydrophenarsazine or with compound (V) shows a very considerable depression of the melting-decomposition point; they are obviously different substances and it must be concluded that the less soluble product of the condensation of *m*-acetyldiphenylamine and arsenious chloride is 10-chloro-1-acetyl-5 : 10-dihydrophenarsazine (VI*a*). From the colour it gives with concentrated sulphuric acid and from its low melting point, the more soluble product is evidently still a mixture of the 1- and 3-acetyl compounds, which it has been found impossible to separate completely.

This is the first example of the realisation of the simultaneous production of the two isomeric monosubstituted 10-chloro-5 : 10-dihydrophenarsazines from the condensation of arsenious chloride with a substituted diphenylamine of type (I). Although a substituted diphenylamine-6′-arsonic acid of type (II) has again only given one of the two possible isomeric 10-chloro-5 : 10-dihydrophenarsazines, it has been possible to show that in this case it is the compound substituted in the 3- position in the dihydrophenarsazine which is produced (compare Gibson and co-workers, J., 1929, 1229; 1930, 1662). It seems reasonable to conclude that the other compounds prepared as above are 10-*chloro*-3-*propionyl*-5 : 10-*dihydrophenarsazine* and 10-*chloro*-3-*butyryl*-5 : 10-*dihydrophenarsazine* respectively, especially as these two compounds give the same blue-purple colour in concentrated sulphuric acid solution indistinguishable from that produced by 10-chloro-3-acetyl-5 : 10-dihydrophenarsazine.

* 3-Bromoacetophenone-4-arsonic acid is described by Gibson and Levin (this vol., p. 2390).

p-*Acetophenonedichloroarsine* has been obtained by the reduction of acetophenone-*p*-arsonic acid (Gibson and Levin, this vol., p. 2399), p-*acetyldiphenylarsonic acid*, $COMe{\cdot}C_6H_4{\cdot}AsPhO{\cdot}OH$, together with its *semicarbazone*, by the Bart–Schmidt reaction on diazotised p-aminoacetophenone, and 4:4′-*diacetyldiphenylarsonic acid*, $(COMe{\cdot}C_6H_4)_2AsO{\cdot}OH$, by the same reaction using *p*-acetophenonearsenious oxide (Gibson and Levin, *loc. cit.*).

The bromination of acetophenone-*p*-arsonic acid, with the object of obtaining bromine-substituted derivatives for use in other condensations with aromatic primary amines, has afforded indications of the production of two compounds containing one atom (possibly in the ω-position) and two atoms of bromine respectively in the molecule; but the analytical figures indicate that the products have not been obtained pure.

EXPERIMENTAL.

3-*Acetyldiphenylamine-6′-arsonic acid* was prepared by boiling for 5 hours a mixture of *m*-bromoacetophenone (21 g.), *o*-aminophenylarsonic acid (22·8 g.), anhydrous potassium carbonate (18·4 g.), amyl alcohol (105 c.c.), and a trace of copper powder. Volatile materials were removed by steam distillation, the resulting aqueous solution boiled with charcoal, and the filtrate acidified with hydrochloric acid. The crude product (22·5 g.; 64% yield) was crystallised first from dilute alcohol and then from dilute acetic acid and obtained in pale buff-coloured prisms, m. p. 154° (Found: As, 22·1. $C_{14}H_{14}O_4NAs$ requires As, 22·4%). When the same series of processes was carried out starting with *m*-aminoacetophenone (5 g.), *o*-bromophenylarsonic acid (10·5 g.), potassium carbonate (8·2 g.), amyl alcohol (33 c.c.), and a trace of copper powder, the crude product obtained weighed 6·5 g. (yield, 52%). This was purified in the same way and had m. p. 154°, identical with that of the 3-acetyldiphenylamine-6′-arsonic acid obtained as above.

10-*Chloro*-3(or 1)-*acetyl*-5:10-*dihydrophenarsazine* (V) was obtained by reducing 3-acetyldiphenylamine-6′-arsonic acid (7·6 g.), dissolved in alcohol (30 c.c.) and hydrochloric acid (30 c.c.), with sulphur dioxide after addition of a trace of iodine. It crystallised from acetic acid in bright yellow needles, m. p. 268—270° (decomp.) after a further recrystallisation from acetone (Found: Cl, 11·2. $C_{14}H_{11}ONClAs$ requires Cl, 11·1%). A very small quantity, added to concentrated sulphuric acid, dissolved, producing an intense blue-purple colour.

10-*Bromo*-3(or 1)-*acetyl*-5:10-*dihydrophenarsazine* was prepared in a similar way using hydrobromic acid. The compound was, as in the previous case, homogeneous and crystallised from acetic

acid in bright yellow needles, m. p. 269° (decomp.) (Found : Br, 21·4. $C_{14}H_{11}ONBrAs$ requires Br, 21·9%).

3(or 1)-*Acetylphenarsazinic acid* was obtained by suspending the above compound (V) (1 g.) in acetone (23 c.c.), adding a solution of chloramine-T (2·05 g.) in water (20 c.c.), and allowing the mixture to stand for 16 hours. After filtration and washing with water, the product was dissolved in warm dilute aqueous sodium hydroxide, and from the filtered solution after addition of hydrochloric acid it was obtained in colourless needles, undecomposed at 290° (Found : As, 23·4. $C_{14}H_{12}O_3NAs$ requires As, 23·6%).

3-*Propionyldiphenylamine*-6′-*arsonic acid* was obtained by condensing *m*-bromopropiophenone (22·5 g.) with *o*-aminophenylarsonic acid (22·8 g.) in the presence of potassium carbonate (18·4 g.), amyl alcohol (105 c.c.), and a trace of copper powder as described for the corresponding acetyl compound. The product crystallised from dilute acetic acid (charcoal) in almost colourless, soft plates, m. p. 160° (Found : As, 21·1. $C_{15}H_{16}O_4NAs$ requires As, 21·5%).

10-*Chloro*-3(or 1)-*propionyl*-5 : 10-*dihydrophenarsazine*.—The preceding compound was reduced in alcohol–hydrochloric acid solution with sulphur dioxide in the presence of a little iodine as described for the corresponding acetyl compound. The *product* crystallised from acetic acid in soft yellow needles, m. p. 227° after previous softening and darkening (Found : Cl, 11·0. $C_{15}H_{13}ONClAs$ requires Cl, 10·6%). A small quantity, dissolved in concentrated sulphuric acid, gave a blue-purple colour indistinguishable from that given by 10-chloro-3-acetyl-5 : 10-dihydrophenarsazine in the same conditions.

3-*Butyryldiphenylamine*-6′-*arsonic acid*, prepared in the usual way by condensing *m*-bromobutyrophenone (17 g.) with *o*-aminophenylarsonic acid (16·3 g.) in the presence of potassium carbonate (13 g.), amyl alcohol (75 c.c.), and a trace of copper powder, was purified by converting it into its sodium salt. This, after drying on porous porcelain, was dissolved in water, and the acid precipitated from the filtered solution by means of hydrochloric acid. On recrystallisation from acetic acid it was obtained in discoloured needles, m. p. 125—126° (Found : As, 21·05. $C_{16}H_{18}O_4NAs$ requires As, 20·65%).

10-*Chloro*-3(or 1)-*butyryl*-5 : 10-*dihydrophenarsazine*.—The previous acid was reduced in alcohol–hydrochloric acid solution in the presence of a little iodine with sulphur dioxide in the usual manner. The product crystallised from acetic acid (charcoal) in orange-coloured needles, m. p. 210° (Found : Cl, 10·45. $C_{16}H_{15}ONClAs$ requires Cl, 10·2%). This compound also gave a blue-purple solution when a small quantity was dissolved in cold concentrated sulphuric acid.

10-*Chloro*-3-*acetyl*-5 : 10-*dihydrophenarsazine* (VII).—A mixture of 3-bromoacetophenone-4-arsonic acid (Gibson and Levin, *loc. cit.*) (14 g.), aniline (5 g.), amyl alcohol (39 c.c.), potassium carbonate (9·6 g.), and a trace of copper powder was boiled for 5 hours. The product obtained as in previous cases could not be purified readily and was immediately dissolved in equal volumes of alcohol and hydrochloric acid and reduced with sulphur dioxide after the addition of a trace of iodine. The *product* was recrystallised several times from acetic acid and obtained in bright yellow needles, m. p. 270° (decomp.) (Found : Cl, 11·7; As, 23·3. $C_{14}H_{11}ONClAs$ requires Cl, 11·1; As, 23·5%). On addition of cold concentrated sulphuric acid to a trace of the compound a deep blue-purple colour developed. Admixture with compound (V) caused no depression of the melting-decomposition point.

3-*Acetyldiphenylamine*-2′-*carboxylic Acid*.—A mixture of *m*-aminoacetophenone (17 g.), potassium *o*-chlorobenzoate (11 g.), amyl alcohol (28 c.c.), and a trace of copper powder was boiled for 6 hours. The *acid*, precipitated by addition of hydrochloric acid to the filtered solution after removal of volatile material by steam distillation, was purified by recrystallisation from dilute acetic acid (charcoal) and obtained after further crystallisation from aqueous alcohol in almost colourless, silky needles, m. p. 166° (Found : C, 70·9; H, 5·35. $C_{15}H_{13}O_3N$ requires C, 70·6; H, 5·1%).

3-*Acetyldiphenylamine* was obtained by heating the preceding compound for 1 hour at 250°. When the tarry product was distilled under reduced pressure, the desired product was obtained, b. p. 240°/20 mm. It solidified on cooling and after recrystallisation from alcohol was obtained in pale yellow prisms, m. p. 93° (Found : C, 80·1; H, 6·5; N, 6·85. $C_{14}H_{13}ON$ requires C, 79·6; H, 6·2; N, 6·6%).

It was found most satisfactory to use monochlorobenzene (20 c.c.) as the medium for the condensation of 3-acetyldiphenylamine (5 g.) with arsenious chloride (5 g.). The mixture was boiled for 8 hours, and the solid product washed with benzene. On recrystallisation from acetone, a portion appeared to be very sparingly soluble and was easily separated. This after further recrystallisation from acetone had m. p. 280° (decomp.) (Found : Cl, 11·6; As, 23·5. $C_{14}H_{11}ONClAs$ requires Cl, 11·1; As, 23·5%). This compound, dissolved in cold sulphuric acid, developed a brilliant red coloration (VI*a*). On admixture with an authentic specimen of 10-chloro-3-acetyl-5 : 10-dihydrophenarsazine (VII) or with compound (V) a considerable depression of the melting-decomposition point was observed; the samples chosen had a melting-decomposition point of about 250°

The more soluble portion after many recrystallisations from acetone had m. p. 250° (decomp.), the highest observed (Found: Cl, 11·65; As, 23·6. $C_{14}H_{11}ONClAs$ requires Cl, 11·1; As, 23·5%). A solution of a very small quantity in cold concentrated sulphuric acid was red-purple.

A solution of acetophenone-*p*-arsonic acid (16 g.) in hydrochloric acid (50 c.c.) was reduced with sulphur dioxide after addition of a little hydriodic acid. The oil which separated was extracted with benzene, the benzene solution dried with calcium chloride, and the benzene evaporated. The p-*acetylphenyldichloroarsine* (acetophenone-*p*-dichloroarsine) was distilled under reduced pressure. It had b. p. 212—215°/30 mm. and crystallised from benzene in colourless rectangular prisms, m. p. 100° (Found: Cl, 26·35. $C_8H_7OCl_2As$ requires Cl, 26·8%). After bromine (1 mol.) had been added to the compound dissolved in carbon tetrachloride, and the mixture warmed on the water-bath, only unchanged *p*-acetylphenyldichloroarsine could be isolated.

p-*Acetyldiphenylarsonic Acid*.—A solution of *p*-aminoacetophenone (7 g.) in hydrochloric acid (10·5 c.c.) and water (50 c.c.) was diazotised below 0° with a solution of sodium nitrite (3·8 g.) in water (6 c.c.). To this solution was added with stirring a solution of phenylarsenious oxide (10 g.) in 10% sodium hydroxide solution (50 c.c.) and then a further 70 c.c. of sodium hydroxide. The reaction was completed by warming on the water-bath until all frothing had subsided; the solution was then made feebly acid with hydrochloric acid and filtered from tarry by-product. The filtrate was made alkaline, concentrated to about 50 c.c. under reduced pressure, filtered from salt, and made acid with hydrochloric acid. The precipitated acid was recrystallised four times from water, and the *compound* thus obtained in colourless needles, m. p. 182°, moderately easily soluble in hot water but very sparingly soluble at the ordinary temperature (Found: As, 21·8. $C_{14}H_{13}O_3As$ requires As, 21·65%). When larger quantities than the above were used, the preparation was much less successful; the chief product isolated was phenylarsonic acid, only a small quantity of *p*-acetyldiphenylarsonic acid being obtained. The *semicarbazone* was obtained by mixing aqueous solutions of *p*-acetyldiphenylarsonic acid (1 g.) and acetonesemicarbazone (0·4 g.); the product slowly separated. It was purified by solution in 2*N*-sodium hydroxide (2 c.c.) (charcoal) and reprecipitation from the filtered solution with hydrochloric acid. From its behaviour on heating, the compound evidently contained water of crystallisation. It began to froth at about 140° and continued to do so until about 190°. The water could not be estimated directly, as it was retained until

about 140° and decomposition then set in (Found: As, 19·9; N, 11·1. $C_{15}H_{16}O_3N_3As,H_2O$ requires As, 19·8; N, 11·1%).

4 : 4′-*Diacetyldiphenylarsonic Acid.*—*p*-Aminoacetophenone (5 g.), dissolved in hydrochloric acid (7·5 c.c.) and water (36 c.c.), was diazotised below 0° with a solution of sodium nitrite (2·8 g.) in water (5 c.c.) and to the resulting solution was added a solution of *p*-acetylphenylarsenious oxide (acetophenone-*p*-arsenious oxide; Gibson and Levin, this vol., p. 2401) (8·75 g.) in 10% sodium hydroxide solution (50 c.c.). After the addition of a further 50 c.c. of the sodium hydroxide solution, the product was worked up as described for *p*-acetyldiphenylarsonic acid. The less soluble product obtained on crystallisation from acetone and then from water was acetophenone-*p*-arsonic acid (m. p. 176°). The acetone mother-liquor was evaporated to dryness, and the residue recrystallised from water. Only a small amount of 4 : 4′-*diacetyldiphenylarsonic acid* was obtained in colourless plates, m. p. 194° (Found: As, 21·3. $C_{16}H_{15}O_4As$ requires As, 21·7%).

Bromination of Acetophenone-p-*arsonic Acid.*—The acid (1 g.) was mixed with bromine (0·8 g.; rather more than 1 mol.) in chloroform (10 c.c.), and the mixture gently warmed. The suspended substance became semi-solid and then completely solid. After cooling and standing for 1 hour, the solid material was recrystallised from dilute acetic acid, colourless prisms being obtained, m. p. 187—190° (Found: As, 25·5; Br, 26·4%. Atomic ratio of As : Br, 1 : 0·97). Acetophenone-*p*-arsonic acid was boiled for 3 hours with an excess of bromine dissolved in carbon tetrachloride. The solid product after recrystallisation from dilute acetic acid had m. p. 196—198° (Found: As, 19·5; Br, 38·0%. Atomic ratio of As : Br, 1 : 1·83).

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