CCXCVI.—*The Reaction between Keto-anils and Grignard Reagents and the Tautomerism of Aliphatic Keto-anils.*

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ATTENTION has frequently been directed to the analogous reactions of the anils and the aldehydes and ketones from which they are derived (Miller and Plöchl, *Ber.*, 1892, **25**, 2020, 2072; 1894, **27**, 1281, 1296; 1896, **29**, 1730; Reddelien, *Ber.*, 1913, **46**, 2714; 1921, **54**, 3133; Strain, *J. Amer. Chem. Soc.*, 1928, **50**, 2218). Although the classical investigations of Busch and his co-workers (*Ber.*, 1904, **37**, 2691; 1905, **38**, 1761) showed that Schiff's bases and aldehydes react with Grignard reagents in a precisely analogous manner, only one example of a reaction between a keto-anil and an organo-magnesium halide is recorded in the literature (see below). The experiments now to be described show that the course of the reaction between keto-anils and Grignard reagents is determined by the nature of the radicals attached to the grouping $>C\colon N\cdot Aryl$.

(1) The aliphatic keto-anils react with magnesium methyl iodide in amyl ether solution to give one molecule of methane and, since practically the whole of the anil may be recovered by decomposition of the resulting Grignard complex, these anils must be capable of reacting in the enamic form $>C\colon CR-NH\cdot Aryl$. The complex obtained by the interaction of acetoneanil and magnesium ethyl bromide reacts with methyl sulphate (compare Gilman and Hoyle, *J. Amer. Chem. Soc.*, 1922, **44**, 2625) to yield methyl*iso*propenylaniline, a compound which Knoevenagel prepared (*Ber.*, 1921, **54**, 1722) by the fission of acetoneanil methiodide with alkali:

$$\{CMe_2\colon NMePh\}I \xrightarrow{NaOH} CH_2\colon CMe\cdot NMePh.$$

Although Bhagvat and Sudborough (*J. Indian Inst. Sci.*, 1912, **2**, 187; *Proc. Asiatic Soc. Bengal*, 1919, **15**, 136) have shown that simple aliphatic aldehydes and ketones are not perceptibly enolised by magnesium methyl iodide, Grignard and Savard (*Compt. rend.*, 1924, **179**, 1573; 1926, **182**, 422) found that some ketones are enolised by Grignard reagents. In order, therefore, to obtain an indication of the constitution of acetoneanil we have applied the refractometric method. The results obtained indicate that acetoneanil must exist mainly in the enamic phase.

	$[R_L]_D$ found.		$[R_L]_D$ calc.
Methyl*iso*propenylaniline...	49·19	$CH_2{:}CMe{\cdot}NHPh$	$44{\cdot}57^a$; $44{\cdot}05^b$
Acetoneanil	44·44	$CMe_2{:}NPh$	$47{\cdot}5^c$

(*a*) Obtained from the observed value for methyl*iso*propenylaniline by subtracting Eisenlohr's value for the refraction of CH_2.

(*b*) Using the CH_2 increment (5·14) derived from the molecular refractions of aniline, mono- and di-methylaniline (Ley and Pfeiffer, *Ber.*, 1921, **54**, 371; Krollpfeiffer, *Annalen*, 1923, **430**, 218).

(*c*) Calculated from Eisenlohr's atomic refractions and the exaltation derived from Auwers's values for the molecular refraction of Schiff's bases (*Ber.*, 1924, **57**, 458).

If it be conceded that acetoneanil is a tautomeric substance in which the enamic form is predominant, it should react with alkyl halides to give halogen acid salts of *N*-alkyl*iso*propenylaniline and not quaternary ammonium salts. Knoevenagel and his co-workers, who observed that the products obtained by the interaction of alkyl halides and ketoanils are decomposed by cold 15—20% sodium hydroxide solution, concluded that "wahrscheinlich verleiht die döppelte Bindung zwischen dem Stickstoff und dem Kohlenstoff den Jodalkylaten der Anile den besonderen Charakter." We find that these compounds decompose sodium carbonate in cold dilute solution, and that, contrary to the statement of these investigators, no difference can be detected between them and the corresponding salts of *N*-alkyl*iso*propenylanilines. It does not appear that these salts are formed by 1 : 3 addition of halogen acids (Decker, *Ber.*, 1905, **38**, 2493), since by analogy with the methiodides of Schiff's bases (Hantzsch and Schwab, *Ber.*, 1901, **34**, 822; Decker and Becker, *Annalen*, 1913, **395**, 362) they should then yield acetone on fission with alkali. In order to test the validity of this conclusion we are investigating Schiff's bases of the type $Aryl{\cdot}CH_2{\cdot}CH{:}N{\cdot}Aryl'$.

The existence of an enimic phase of acetoneanil is strongly suggested by the ease with which this compound is hydrolysed and it also appears probable that it is initially produced in this form, since we find that acetone does not condense with methylaniline under the conditions employed in the preparation of acetoneanil.

In acetoneanil we have, so far as we are aware, the first simple instance of the tautomeric system $>CH\cdot\underset{\cdot}{C}:N\cdot \rightleftharpoons >C:\underset{\cdot}{C}\cdot\underset{\cdot}{N}H$.* The existence of functional tautomerism of this type has, however, been postulated to account for the production of β-disubstituted pyrroles (Meyer and Jacobson, "Lehrbuch," 2, iii, 150) and the activity of α-methyl groups in pyridine and other heterocyclic bases (Mills and Smith, J., 1922, **121**, 2724) (compare also Eibner, *Annalen*, 1901, **318**, 165; Lesslie and Turner, J., 1929, 1512).†

(2) The interaction of acetophenoneanil with magnesium phenyl bromide has been investigated by Plancher and Ravenna (*Atti R. Accad. Lincei*, 1906, v, **15**, ii, 555). The product of the reaction is a substance, $C_{20}H_{19}N$, m. p. 94—96°, indexed in Beilstein's "Lexikon" (4th Ed., **12**, 1327) as $MeCPh_2\cdot NHPh$. We had no difficulty in obtaining this substance by following the instructions of Plancher and Ravenna, but found that its formula is $C_{22}H_{19}N$. It cannot be acetylated, does not yield a nitrosoamine, and yields dypnone on hydrolysis. The substance is therefore dypnoneanil and has been produced by the condensation of two molecules of acetophenoneanil under the influence of magnesium phenyl bromide. In agreement with this conclusion we find that the same substance is produced by the action of one molecule of magnesium ethyl bromide with two molecules of acetophenoneanil:

$$2PhCMe:NPh + RMgX \longrightarrow PhCMe:CH\cdot CPh:NPh + PhNH\cdot MgX + RH.$$

(3) The recovery of benzophenoneanil unchanged after its vigorous reaction with Grignard reagents recalls the behaviour of $Ph\cdot NMe\cdot CH_2\cdot CH_2\cdot MgBr$, which unites with ketones to yield complexes from which the ketone is regenerated quantitatively by the action of water (von Braun, *Ber.*, 1913, **46**, 1266; 1917, **50**, 1650; 1919, **52**, 1725).

EXPERIMENTAL.

(1) Acetoneanil (Knoevenagel, *Ber.*, 1921, **54**, 1725; 1922, **55**, 1918) has m. p. 23·5° and (supercooled) $d_4^{20°}$ 1·0087 and $n_D^{20°}$ 1·5886. 0·1750 G. of acetoneanil with excess of magnesium methyl iodide

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* The acetylation of keto-anils will be described in a subsequent communication.

† While this paper was in the press von Auwers and Susemihl (*Ber.*, 1930, **63**, 1081) published the results of spectrochemical investigations which show that compounds of the type $NH:\dot{C}\cdot CH_2X$ (where $X = CO_2Et$, $\dot{C}O$, or $\dot{C}N$) exist mainly in the form $NH_2\cdot\dot{C}:CHX$.

in amyl ether gave 29·2 c.c. of dry methane at 18·7° and 767 mm., equivalent to 0·94 atom of active hydrogen per molecule.

The product from the interaction of acetoneanil (13 g.) and magnesium phenyl bromide (bromobenzene, 16 g.; magnesium, 2·4 g.; ether, 25 c.c.) was decomposed with ice-cold ammonium chloride solution, the oil extracted with ether, and the extract dried over sodium sulphate. Most of the benzene distilled with the ether, the fraction below 128°/13 mm. (3 g.) consisted of benzene, aniline (benzanilide, m. p. 161—162°), and a little acetoneanil, whilst the main fraction (9·5 g.), b. p. 128—133°/13 mm., was almost pure acetoneanil. The residue was resinous.

To the product of the interaction of acetoneanil (13 g.) with magnesium ethyl bromide (ethyl bromide, 11 g.; magnesium, 2·4 g.; ether, 20 c.c.) was gradually added methyl sulphate (12·6 g.) in much ether. The reaction was extremely vigorous and the product, a thick paste, was decomposed with ammonia and ammonium chloride solution. The main fraction of the product (9 g.) distilled between 140° and 147°/15 mm. and was identified as methyl*iso*propenylaniline by the preparation of a di-iodide, m. p. and mixed m. p. 139—140° (Knoevenagel, *Ber.*, 1922, **55**, 1918). Methyl*iso*propenylaniline, b. p. 146°/15 mm., prepared by Knoevenagel's method (*loc. cit.*), had $d_{4^\circ}^{20^\circ}$ 1·0030; $n_{D}^{20^\circ}$ 1·5856.

*Benzyl*iso*propenylaniline Hydrochloride.*—Acetoneanil (1 mol.), benzyl chloride (1·05 mols.), and benzene (5%) yielded crystals after 3 days (hastened by shaking). The product (yield, almost theoretical) was recrystallised from alcohol by addition of acetone and was obtained in white needles, m. p. 195° (decomp.), very readily soluble in alcohol but very sparingly in benzene, ligroin, acetone and ethyl acetate. It was immediately decomposed by cold dilute sodium carbonate solution and was titrated against 0·1*N*-barium hydroxide and phenolphthalein (0·3020 g. neutralised 11·68 c.c. Cl, 13·7. $C_{16}H_{18}NCl$ requires Cl, 13·7%).

*Benzyl*iso*propenylaniline.*—The above *hydrochloride* was decomposed by shaking with cold dilute sodium carbonate solution. The oil which separated soon solidified and was pressed on a porous plate. The white substance, m. p. 22—23°, obtained was extremely soluble in the usual organic solvents and could not be recrystallised (Found: C, 86·0; H, 7·7; N, 6·4. $C_{16}H_{17}N$ requires C, 86·1; H, 7·6; N, 6·3%). When an ethereal solution of the base is treated with dry hydrogen chloride, the hydrochloride produced is identical with that described above.

Methyl*iso*propenyl-*p*-toluidine hydriodide,* prepared by the interaction between acetone-*p*-tolil and methyl iodide (Knoevenagel,

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* Knoevenagel's acetone-*p*-tolil methiodide (*Ber.*, 1921, **54**, 1720).

loc. cit.), may be recrystallised from alcohol or benzene. It has m. p. 145—146° (decomp.) after sintering at 142—143°. The same compound (m. p. and mixed m. p.) is obtained by passing a current of pure dry hydrogen iodide for *a short time* into a benzene solution of methyl*iso*propenyl-*p*-toluidine. Knoevenagel, however, records m. p. 80—82° for this substance.

(2) Acetophenoneanil (9 g.), prepared by Reddelien's method (*Ber.*, 1910, **43**, 3478), was condensed with magnesium phenyl bromide as described by Plancher and Ravenna (*loc. cit.*). A small quantity of aniline (benzanilide, m. p. 161°) was obtained together with a substance (4·8 g.), m. p. 97° after recrystallisation from alcohol (Found: C, 88·65; H, 6·4; N, 4·8. Calc.: C, 88·8; H, 6·4; N, 4·7%). This substance did not depress the melting point of dypnoneanil (Reddelien, *Ber.*, 1913, **46**, 2712) and was further identified (i) by hydrolysis to dypnone (m. p. and mixed m. p. of *anti*-oxime 74—75°) and aniline (benzanilide, m. p. 160°), (ii) by conversion into 1 : 3 : 5-triphenylbenzene (m. p. 170·5—171°, mixed m. p. 169·5—170·5°) by heating with aniline hydrochloride (Reddelien, *loc. cit.*).

Dypnoneanil is also obtained in 81% yield by the action of magnesium ethyl bromide upon acetophenoneanil, and the absence of benzene in the product considerably simplifies the recovery of the dypnoneanil. An experiment in which only a small quantity of magnesium ethyl bromide was employed resulted in a correspondingly low yield of dypnoneanil, so that the Grignard reagent must necessarily combine with the aniline produced from the condensation of the acetophenoneanil.

(3) Benzophenoneanil (12·8 g.), prepared by Reddelien's method (*Ber.*, 1913, **46**, 2720) and dissolved in dry benzene, was added (much heat evolved) to a Grignard solution prepared from magnesium (1·2 g.), methyl iodide (7·0 g.) and ether (25 c.c.). The product was decomposed with ice-cold ammonia and ammonium chloride solution, and the benzene–ether solution dried over sodium sulphate. On removal of the solvent practically the whole of the benzophenoneanil (m. p. 113°) was recovered.

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