In the cholestane series, it was shown that the A-ring aromatic hydrocarbons produced by the rearrangement reaction unfortunately resulted in oily products. Accordingly, repetition of this rearrangement reaction was conducted on an androstane series, which would give rise to a crystalline product, in order to establish a further structural proof. 4,4-Dimethylandrost-5-ene-3,17-dione 3,17-bis cyclic ethylene ketal (Ⅱb) was treated with *p*-toluenesulfonic acid in ethylene glycol. From the reaction there was obtained a mixture, readily separable by column chromatography. An aromatic product, m.p. 139°, $[\alpha]_D^{15}$ +100° (c=0.2, $CHCl_3$), for which the elemental analysis agreed with the empirical formula $C_{23}H_{32}O_2$, was assigned to be 1,3,4-trimethylestra-1,3,5(10)-trien-17-one cyclic ethylene ketal by IR ν_{max} cm^{-1} : 1743, 1716, 1691, 1598, and 1560 (weak bands); 864 (C–H out-of-plane deformation), UV : λ_{max}^{EtOH} mμ (log ε) : 271 (2.52), and NMR data : 0.90 (18-methyl); 2.10, 2.21, and 2.30 (three methyls on A-ring); 3.91 (ethylenedioxy); 6.84 (one aromatic hydrogen).

The structure of an aromatic compound was confirmed to be 1,3,4-trimethylestra-1,3,5(10)-trien-17-one cyclic ethylene ketal (Ⅲc) by the following synthesis. Reaction of 17β-acetoxy-4-methylandrosta-1,4-dien-3-one (Ⅳb) with methyl Grignard reagent, followed by hydrochloric acid treatment, chromium trioxide oxidation, and ketalization with ethylene glycol gave a crystalline, m.p, 139°, which was identical in all respects with the sample obtained by the above aromatization (Ⅱb→Ⅲc).

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Reduction of Acid Amides to Amines with Sodium Borohydride

The preparation of amines from various acid amides is one of the most important reactions, and the reduction of acid amides with lithium aluminum hydride has been widely studied.[1,2] Complex borohydride, sodium trialkoxyborohydride ($NaBH(OR)_3$)[3] which reacts as medium reducing agent converts acid amides into the corresponding amines in some cases,[4] the reduction of secondary and tertiary amides with lithium borohydride or sodium borohydride-lithium chloride has also been reported,[5~7] the combination of sodium borohydride and aluminum chloride has also been applied successfully to the conversion of amides and lactams to the corresponding amines.[8~10]

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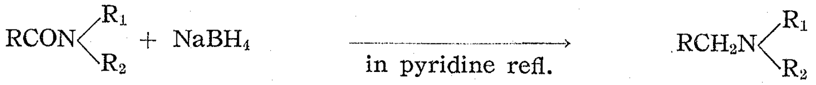
Recently, diborane has been shown to be a mild and effective reducing agent for the reduction of various amides[11] and monofluoroacetamides.[12]

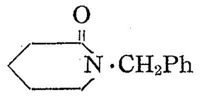
No report for converting an acid amide to the corresponding amine with only the mild reducing agent, sodium borohydride, has been hitherto published except a Patent[13] claiming the preparation of amines by the fusion of acid amides with sodium borohydride at a temperature above the melting point of the mixture.

The present procedure has permitted the reduction of tertiary amides to the corresponding tertiary amines with sodium borohydride in refluxing pyridine in moderate yield. The experimental results are summarized in Table I.



$$RCON\genfrac{}{}{0pt}{}{R_1}{R_2} + NaBH_4 \xrightarrow[\text{in pyridine refl.}]{} RCH_2N\genfrac{}{}{0pt}{}{R_1}{R_2}$$

Table I.

No.	R	R_1	R_2	Reaction time (hr.)	Yield of amines (%)	Recovery of starting materials (%)
1	$PhCH_2CH_2$	H	H	20	56[a]	small
2	〃	〃	CH_3	20	0	100
3	〃	CH_3	〃	20	51	trace
4	〃	C_2H_5	C_2H_5	20	0	90
5	〃	$-(CH_2)_5-$		20	71	trace
6	〃	CH_3	Ph	20	0	71[b]
7	Ph	C_2H_5	C_2H_5	10	55	trace
8	〃	$-(CH_2)_5-$		10	51	〃
9				10	66	0

a) Yield of obtained hydrocinnamonitrile instead of amine.
b) The corresponding alcohol was contaminated in this substance.

Both N,N-dimethylhydrocinnamamide and N,N-diethylbenzamide were reduced to the corresponding tertiary amines with a trace of recovery of starting amides under the reaction conditions listed, and aromatic tertiary amide seemed to be reduced faster than the aliphatic derivative. However, it was found that the reduction of N,N-diethylhydrocinnamamide did not take place and the starting material was recovered in the neighborhood of 90% under the similar reaction conditions.

The piperidine derivatives such as N-benzoyl- and N-hydrocinnamoyl-piperidine and the lactam, 1-benzyl-2-piperidinone, were also smoothly reduced in 50~70% yield.

N-Methylanilides are well known to produce aldehydes with lithium aluminum hydride,[14] but under the present procedure the reduction of N-methylhydrocinnamanilide did not take place and the starting material was recovered with the formation of a small amount of an alcohol suggested by infrared band of this material.

We can not clearly explain the reason why the reduction did not occur in case of N,N-diethylhydrocinnamamide. However, presumably, it would be suggested that this reaction involves high steric requirement.

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Only secondary amide tested, N-methylhydrocinnamamide was not reduced by the present procedure and the recovery of the starting material was quantitative.

Surprisingly, in case of primary amide, the reduction of hydrocinnamamide did not occur, instead, the amide underwent dehydration to give hydrocinnamonitrile. In previous reports, acidic dehydrating agents[15,16] such as phosphoryl chloride and thionyl chloride, are ordinary employed to obtain nitriles from primary amides. Therefore, it should be mentioned that dehydration with sodium borohydride, the basic agent, is of great interest.

General procedure : A mixture of 0.01 mole of acid amide and 0.03 moles of sodium borohydride in 20 ml. of pyridine was gently refluxed for 10~20 hours, the solvent was removed under reduced pressure, 10% of hydrochloric acid was added, the acidic solution was warmed on a water bath for 20~30 minutes and then extracted with ether to remove the starting material or to obtain a nitrile. The aqueous layer was made alkaline with 10% potassium hydroxide and extracted with ether, the ether extract was washed with water and dried over anhydrous sodium sulfate, ether was evaporated and the residual amine was distilled. In case of obtaining a nitrile, the ether extract from acidic layer was treated as usual. The actual yields given in Table I are probably not the highest values.

As mentioned above, the marked difference observed in the reaction of primary, secondary and tertiary amides with sodium borohydride in refluxing pyridine is noteworthy.

Investigations are now continuing on the scope and mechanism of these new type reactions.

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Study on N^{15}-H Spin-Spin Coupling of 4-Nitroquinoline 1-Oxides Containing Deuterium and/or Nitrogen-15

Not so many studies have been reported on the nitrogen-proton spin-spin interactions in a system of $N-CH_{\alpha}-CH_{\beta}$. A fairly strong spin-spin coupling was recently observed[1] between quaternary nitrogen-14 nucleus and β-hydrogen (CH_3) but not between nitrogen and α-hydrogen (CH_2) of tetraethylammonium halogenides. No such coupling has been clearly observed for any N^{14} compounds other than the above quaternary amines and isonitriles,[2] so far.

Now, we wish to report on the spin-spin interactions of aromatic ring protons with the nitrogen contained in an aromatic ring or a nitro group, using N^{15} substituted quinoline 1-oxide and 4-nitroquinoline 1-oxides, I, III, IV, and V. The syntheses of N^{15}

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