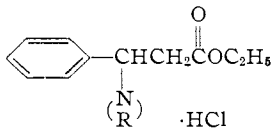
TABLE II

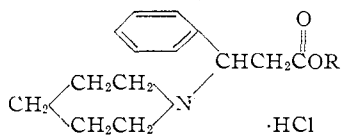
ETHYL β-(N-HETEROCYCLIC)-β-PHENYLPROPIONATE HYDROCHLORIDES



Heterocyclic group	Molecular formula	Yield, %	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found
1-Pyrrolidyl	$C_{16}H_{22}NO_2Cl$	18	63.62	63.28	7.82	7.76
1-Piperidyl	$C_{16}H_{24}NO_2Cl$	20	64.52	64.36	8.12	8.22
4-Morpholinyl	$C_{15}H_{22}NO_3Cl$	20	60.09	60.43	7.40	7.49
1-(4-Me)-piperidyl	$C_{17}H_{26}NO_2Cl$	17	65.47	65.42	8.42	8.40

TABLE III

ALKYL β-(1-PIPERIDYL)-β-PHENYLPROPIONATE HYDROCHLORIDES



Alkyl group	Molecular formula	Yield, %	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found
Methyl	$C_{15}H_{22}NO_2Cl$	19	63.47	63.34	7.82	7.95
Ethyl	$C_{16}H_{24}NO_2Cl$	20	64.52	64.36	8.12	8.22
n-Propyl	$C_{17}H_{26}NO_2Cl$	22	65.47	65.83	8.42	8.55
n-Butyl	$C_{18}H_{28}NO_2Cl$	16	66.33	66.10	8.67	8.68
n-Amyl	$C_{19}H_{30}NO_2Cl$	12	67.13	67.24	8.91	8.76
n-Hexyl	$C_{20}H_{32}NO_2Cl$	8	67.86	67.76	9.13	9.22
2-Methylpropyl	$C_{18}H_{28}NO_2Cl$	7	66.33	66.16	8.67	8.55
1-Methylpropyl	$C_{18}H_{28}NO_2Cl$	6	66.33	66.48	8.67	8.57
1-Methylbutyl	$C_{19}H_{30}NO_2Cl$	4	67.13	67.10	8.91	8.87

cium sulfate. The solvent was removed by distillation on the steam-bath under water-pump vacuum. The residue was then vacuum distilled. The yields and boiling ranges of these esters are listed in Table I.

Reaction of Saturated Heterocyclic Amines with Cinnamate Esters.—Since the procedure used in preparing the β-(N-heterocyclic)-β-phenylpropionate esters was basically the same in all cases, detailed directions are given for only one representative compound. The physical properties of these compounds are listed in Tables II and III.

Ethyl β-(1-Piperidyl)-β-phenylpropionate.—Ethyl cinnamate (17.6 g., 0.1 mole) and piperidine (8.5 g., 0.1 mole) were dissolved in 30 ml. of heptane and the solution refluxed for 8 hr. After the solution had cooled to room temperature, it was washed with three 30-ml. portions of distilled water. The organic layer was then extracted with two 30-ml. portions of 3 *N* hydrochloric acid. These acid aqueous extracts were combined and made basic to *p*H 8 by the addition of granular potassium carbonate. The resultant oil was then extracted with two 50-ml. portions of ether. The ethereal extracts were combined and dried over anhydrous calcium sulfate. The dry ether solution was then treated with dry hydrogen chloride until acid to congo red paper. The precipitated white solid was recrystallized three times from 2-propanol; yield 6.0 g., 20.1%.

It was found that the yield of product was increased to 45% of the theoretical when the reaction was run in toluene solution in the presence of 1 ml. of a 10% aqueous solution of tetramethylammonium hydroxide solution. By employing a two-mole excess of piperidine, the yield was increased to 75% of the theoretical.

N-Cinnamylpiperidine.—A mixture of ethyl cinnamate (52.8 g., 0.3 mole) and piperidine (25.5 g., 0.3 mole) was refluxed for 70 hr. The unchanged reactants and ethanol were removed by distillation at 0.5 mm. When the temperature reached 80°, the distillation was discontinued. After cooling to room temperature, the material in the pot solidified. This solid material, N-cinnamylpiperidine, was recrystallized twice from absolute ethanol and washed with petroleum ether, yield 46.5 g., 71%.

Anal. Calcd. for $C_{14}H_{17}NO$: C, 78.14; H, 7.97. Found: C, 78.23; H, 8.03.

GAINESVILLE, FLORIDA

[CONTRIBUTION FROM THE DANIEL SIEFF RESEARCH INSTITUTE, WEIZMANN INSTITUTE OF SCIENCE]

Reduction and Benzylation by Means of Benzyl Alcohol. III. Experiments in the Pyridine Series[1]

BY MOSHE AVRAMOFF AND YAÏR SPRINZAK

RECEIVED JANUARY 14, 1956

The behavior of pyridine, its benzologs and their derivatives toward benzyl-alcoholic potassium hydroxide has been studied. Methyl groups in the pyridine ring are readily benzylated. On prolonged heating, dibenzylated products are obtained. It is shown that the reaction involves condensation with benzaldehyde and reduction of the resulting styryl derivative. Two instances of benzylation of a "non-active" side-chain have been encountered. Quinoline is transformed into 1,2,3,4-tetrahydroquinoline, 3-benzylquinoline and 3-benzyl-1,2,3,4-tetrahydroquinoline, which can be obtained in good yield. The formation of these products is explained in terms of partial reduction of the pyridine ring, followed by two concurrent reactions: (1) reduction to 1,2,3,4-tetrahydroquinoline and (2) condensation of dihydroquinoline with benzaldehyde to form 3-benzal-3,4-dihydroquinoline, which isomerizes to 3-benzylquinoline. The latter is then reduced to 3-benzyl-1,2,3,4-tetrahydroquinoline. 3-Methyl- and 3-phenyl-quinoline are also reduced under the same conditions. Carbostyryl yields 3-benzylcarbostyryl. Isoquinoline is benzylated to 4-benzylisoquinoline. No reduction products have been observed in the pyridine and isoquinoline series.

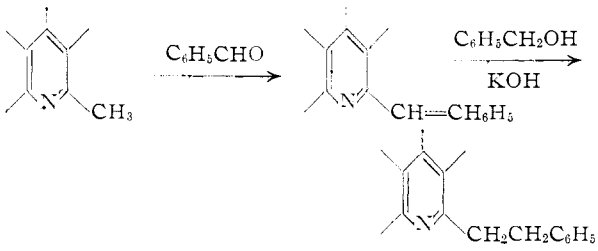
In previous parts[2] of this series we have discussed the carbon-benzylation of fluorene and its derivatives and the nitrogen-benzylation of primary aromatic amines by means of benzyl-alcoholic potassium hydroxide. It was shown that in both cases the reaction involved the formation of intermediate benzylidene derivatives, readily reducible by the reagent. It was further pointed out that this easy reduction was due to the polar character of the newly formed double bond.

In the present work the behavior of nitrogen-containing aromatic heterocyclic compounds toward the reagent has been studied. It was expected that the polarity induced by the presence of the tertiary nitrogen atom would give rise to: (a) reduction of the heterocyclic ring and (b) benzylation of "active" side-chains by a process in-

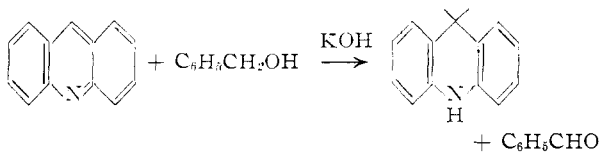
(1) Presented in part at the XIVth International Congress of Pure and Applied Chemistry, Zurich, July, 1955. Taken in part from the Ph.D. Thesis submitted to the Hebrew University of Jerusalem by Moshe Avramoff.

(2) Y. Sprinzak, (a) THIS JOURNAL, **78**, 466 (1956); (b) *ibid.* **78**, 3207 (1956); *cf.* British Patent 726,545 (Jan. 1, 1953).

volving condensation with benzaldehyde and reduction of the unsaturated condensation product



Reactions of type a appeared to us all the more likely in view of an experiment where acridane was readily formed from acridine by treatment with the above reagent.

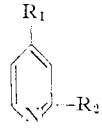


Reaction b could be anticipated because of the analogous benzylation of the active methylene group in fluorene.[2a]

Accordingly pyridine, quinoline, isoquinoline and their derivatives have been submitted to the action of boiling benzyl-alcoholic potassium hydroxide. Since preliminary experiments have shown that reaction was more effective under anhydrous conditions, water was usually removed from the hydroxide solution by distillation, prior to the addition of the heterocyclic compound. The potassium benzylate solution[3] so prepared will subsequently be referred to as "the reagent."

The discussion of the reactions observed will be divided, in accordance with the products obtained, into side-chain reactions and reactions of the heterocyclic ring.

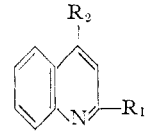
Side-chain Reactions.—2- and 4-picoline are benzylated by the reagent to form the corresponding phenethylpyridines (I and III) in good yields. There is a marked difference in the reactivity of the picolines, a longer reaction time being required in the case of the 2-isomer. On longer treatment, the phenethyl group is further benzylated to the diphenylisopropyl group, to give II and IV. Here again the reaction is faster with 4-phenethylpyridine. This difference is in contrast with the greater reactivity of 2-picoline as compared with that of 4-picoline in the alkylation with benzyl chloride in the presence of potassium amide.[4]



I, R_1 = H, R_2 = $CH_2CH_2C_6H_5$
II, R_1 = H, R_2 = $CH(CH_2C_6H_5)_2$
III, R_1 = $CH_2CH_2C_6H_5$, R_2 = H
IV, R_1 = $CH(CH_2C_6H_5)_2$, R_2 = H

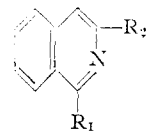
The methyl group in β-picoline has always been considered as entirely unreactive toward reagents which attack α- and γ-methyl groups.[5] We nevertheless submitted β-picoline to the action of the reagent and isolated a small quantity of a benzylated picoline. Our conclusion that benzylation of the methyl group occurred is strengthened by the surprising finding, reported recently by Brown and Murphey, that β-picoline could be methylated in the presence of sodium amide.[6,6a]

In the quinoline group, quinaldine (V) and lepidine (VIII) were readily monobenzylated to the corresponding phenethylquinolines VI and IX. Similarly, 2,4-dimethylquinoline (XI) yielded 2,4-diphenethylquinoline (XII). Its structure has been proven by comparison with a sample obtained by catalytic hydrogenation of 2,4-distyrylquinoline (XIII). As in the phenethylpyridines, the side-chain can be further benzylated to the diphenylisopropyl group. Thus, IX and XII are converted to X and XIV, respectively. VI, however, is not further benzylated. A possible explanation for this exception will be given below.



V, R_1 = CH_3, R_2 = H
VI, R_1 = $CH_2CH_2C_6H_5$, R_2 = H
VII, R_1 = $CH{=}CHC_6H_5$, R_2 = H
VIII, R_1 = H, R_2 = CH_3
IX, R_1 = H, R_2 = $CH_2CH_2C_6H_5$
X, R_1 = H, R_2 = $CH(CH_2C_6H_5)_2$
XI, R_1 = R_2 = CH_3
XII, R_1 = R_2 = $CH_2CH_2C_6H_5$
XIII, R_1 = R_2 = $CH{=}CHC_6H_5$
XIV, R_1 = R_2 = $CH(CH_2C_6H_5)_2$

In the isoquinoline group, experiments were carried out with 1-methyl- and 3-methyl-isoquinoline. Under comparable conditions, they reacted to yield the expected phenethylisoquinolines XV and XVIII in 38 and 12% yields, respectively. This difference of reactivity is in line with the known relative inertness of the 3-isomer.[7] A difference is also apparent in the further benzylation of the phenethyl compounds to the diphenylisopropyl derivatives XVI and XIX, a longer period of reaction being required to obtain XIX. The identity of the two phenethylisoquinolines was confirmed by comparison with samples obtained by catalytic hydrogenation of the corresponding styryl derivatives (XVII and XX).[8]



XV, R_1 = $CH_2CH_2C_6H_5$, R_2 = H
XVI, R_1 = $CH(CH_2C_6H_5)_2$, R_2 = H
XVII, R_1 = $CH{=}CHC_6H_5$, R_2 = H
XVIII, R_1 = H, R_2 = $CH_2CH_2C_6H_5$
XIX, R_1 = H, R_2 = $CH(CH_2CH_2C_6H_5)_2$
XX, R_1 = H, R_2 = $CH{=}CHC_6H_5$

In confirmation of the course suggested above for the side-chain benzylation, 2-styrylquinoline (VII) was formed from quinaldine and benzaldehyde in

(3) According to A. Wacker [French Patent 653,818 (May 5, 1928); *Chem. Zentr.*, **100**, I, 3036 (1929)] this solution is equivalent to a solution obtained by dissolving potassium metal in benzyl alcohol.

(4) F. W. Bergstrom, T. R. Norton and R. A. Seibert, *J. Org. Chem.*, **10**, 452 (1945).

(5) Cf. A. P. Phillips, THIS JOURNAL, **74**, 3295 (1952).

(6) H. C. Brown and W. A. Murphey, *ibid.*, **73**, 3308 (1951); see also D. A. Brown and M. J. S. Dewar, *J. Chem. Soc.*, 2406 (1953).

(6a) Since our manuscript was submitted 3-phenethylpyridine has been described by A. D. Miller, C. Osuch, N. N. Goldberg and R. Levine [THIS JOURNAL, **78**, 674 (1956)]. A mixed melting point determination with a sample kindly supplied by Prof. R. Levine, University of Pittsburgh, confirmed the identity of our product with the above compound.

(7) R. C. Elderfield, "Heterocyclic Compounds," Vol. IV, John Wiley and Sons, Inc., New York, N. Y., 1952, pp. 449–452.

(8) E. Vongerichten and W. Homann, *Ber.*, **45**, 3446 (1912), have suggested the structure XV for a solid product of m.p. 86–86.5°, isolated in the zinc-dust distillation of "Isochinolinrot," on the ground of elementary analysis alone. As our compound is liquid, and since, from consideration of the formula given for "Isochinolinrot," it is by no means obvious that it could give rise to XV, we believe that the formulation of Vongerichten and Homann is incorrect.

the presence of the reagent, when the reaction was carried out at a temperature sufficiently low (130–140°) to prevent reduction of the product. Reduction of 2-styrylquinoline to the phenethyl compound was achieved by treatment with the boiling reagent.

The present method of side-chain benzylation is evidently simpler and more convenient than the usual method, which employs benzyl chloride and sodium amide in liquid ammonia.

Reactions of the Heterocyclic Ring.—Attack of the ring was not observed in experiments with pyridine and its derivatives. While, as mentioned above, picolines and phenethylpyridines were benzylated in the side-chain, pyridine and 2-phenylpyridine were recovered unchanged.

Interesting results have been obtained with quinoline. When this compound was treated with the boiling reagent for a short time (10 minutes), a benzylated product was isolated. It was identified as 3-benzylquinoline (XXIV) by comparison with a sample prepared, according to Borsche,[9] by decarboxylation of the product of condensation of isatin and benzylpyruvic acid. Longer times of reaction (up to 5 hr.) resulted in the formation of 3-benzyl-1,2,3,4-tetrahydroquinoline (XXV), isolable in a 43% yield, together with a small quantity (10%) of 1,2,3,4-tetrahydroquinoline (XXII). When 3-benzylquinoline was treated with the reagent, it was converted to 3-benzyl-1,2,3,4-tetrahydroquinoline, whose structure was proved by dehydrogenation to the starting compound. 1,2,3,4-Tetrahydroquinoline, on the other hand, was not attacked by the reagent.

The following reaction course is suggested for the formation of the products obtained from quinoline: in the first place, partial reduction of the heterocyclic ring occurs. In analogy with the case of acridane, the reduction product may be formulated as 1,4-dihydroquinoline (XXIa); a 1,2-reduction to yield XXIb seems, however, equally possible, as it is well known that the azomethine linkage of pyridine and its benzologs is susceptible to attack by a variety of reagents.[10] It may further be assumed that, under the strongly basic conditions, the three possible dihydroquinolines (XXIa,b,c) exist in equilibrium with each other.[11] Subsequently, two concurrent reactions take place: (1) reduction to 1,2,3,4-tetrahydroquinoline (XXII); (2) condensation with the benzaldehyde formed in the reduction steps. It may be inferred from the final result, indeed even anticipated, that of the three dihydroquinolines, the 3,4-isomer should present the more active methylene group for this condensation, owing to the vicinity of the C=N group.[12] The 3-benzal-3,4-dihydroquinoline (XXIII) formed would then isomerize to the more stable (aromatic) 3-benzylquinoline (XXIV), which is subsequently reduced to XXV.

Similarly to XXIV, other 3-substituted quinolines, including 3-methyl- and 3-phenyl-quinoline, were also reduced by the reagent to the corresponding tetrahydro compounds.

The only reaction observed with lepidine and 2,4-dimethylquinoline was the side-chain benzylation mentioned above. Quinaldine, on the other hand, was ultimately reduced to 2-phenethyl-1,2,3,4-tetrahydroquinoline. The destruction of aromaticity brought about by this reduction may account for the fact that 2-phenethylquinoline, unlike its 4-isomer, is not further benzylated (see above). 2-Phenylquinoline was not attacked by the reagent. In contrast, carbostyryl (2-hydroxyquinoline) yielded 3-benzylcarbostyryl, whose structure has been confirmed by conversion to 3-benzyl-2-chloroquinoline followed by dehalogenation to 3-benzylquinoline.

In analogy with quinoline, isoquinoline is benzylated in the β-position with regard to the nitrogen atom, to give 4-benzylisoquinoline (XXVI) in 60% yield. In view of the simplicity of this reaction, it may be mentioned that the only method recorded for the preparation of XXVI involves seven reaction steps.[13] In contrast with quinoline, no reduction products could be isolated in this case. At the same time, a small quantity of a dibenzylated by-product, presumably 1,2-diphenyl-2-(4′-isoquinolyl)-methane (XXVII), was formed. It was obtained in a 26% yield when XXVI was used as the starting material. This is another instance, similar to that of 3-picoline, where a conventionally non-active side-chain is attacked by the reagent. That

(9) W. Borsche, *Ann.*, **532**, 127 (1937).

(10) (a) Reference 7, pp. 246 ff. (b) For reduction by lithium-aluminum hydride, *cf.* F. Bohlman, *Chem. Ber.*, **85**, 390 (1952); K. W. Rosenmund and F. Zymalkowski, *ibid.*, **86**, 37 (1953).

(11) *Cf.* base-catalyzed prototropy in triad systems; C. K. Ingold and C. W. Shoppee, *J. Chem. Soc.*, 447, 1199 (1929).

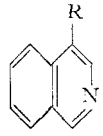
(12) Activation of an α-methylene group by the C=N group is manifested in the easy self-condensation of Schiff bases, *e.g.*

$$2C_3H_7CH{=}NC_4H_9 \longrightarrow C_2H_5\underset{\underset{CH{-}C_3H_7}{\|}}{C}CH{=}NC_4H_9 + C_4H_9NH_2$$

W. S. Emerson, S. M. Hess and F. C. Uhle, THIS JOURNAL, **63**, 872 (1941).

(13) J. v. Braun, O. Bayer and L. Cassel, *Ber.*, **60**, 2602 (1927).

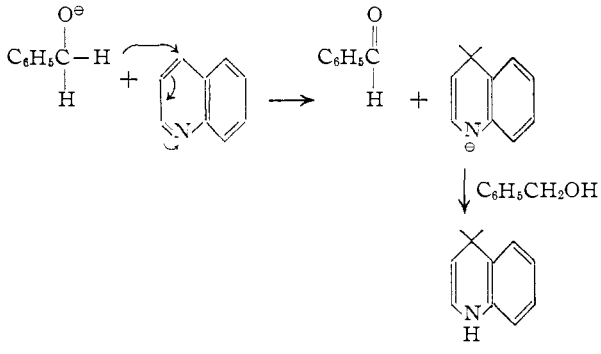
3-methyl- and 3-benzyl-quinoline escape a similar attack may be due to the slowness of this reaction compared with the reduction of the heterocyclic ring. The course outlined above for the formation of 3-benzylquinoline may be applied to the case of 4-benzylisoquinoline.



XXVI, R = $CH_2C_6H_5$
XXVII, R = $CH(C_6H_5)CH_2C_6H_5$

In order to provide support for this suggestion, the only stable dihydroisoquinoline known, *viz.*, the 3,4-isomer,[14] was used as the starting material. As in the case of isoquinoline itself, heating with the reagent under reflux resulted in the formation of XXVI. At a lower temperature (110–120°), the dihydro compound was recovered unchanged after a reaction time of 30 minutes; on the other hand, a 10% yield of 4-benzylisoquinoline was isolated when benzaldehyde was added to the reaction mixture under the same conditions. While it was felt that a similar experiment with a dihydroquinoline was desirable, the idea was abandoned because of the reported instability of the only known compound of this type, *viz.*, 1,2-dihydroquinoline, and the contradictory claims in regard to the melting points of the free base and of its picrate.[15]

The mechanism of the initial step of the reaction, *i.e.*, partial reduction of the pyridine ring, may be represented by Doering's formulation for the reduction of carbonyl compounds by alkoxide ions,[16] as applied by Pratt and Frazza to the reduction of Schiff bases.[17] The mechanism of the 1,2-reduction of the pyridine ring would then be identical with that given by Pratt and Frazza, while a slight modification is required for the 1,4-attack of the ring



Experimental

All the heterocyclic compounds used were Eastman Kodak Co. products, unless otherwise mentioned. All melting points are corrected. Yields are based on starting material consumed in the reaction. The identity of all known compounds, for which physical data are given, was checked by elementary analysis. Most of the analyses were performed by Drs. G. Weiler and F. B. Strauss, Oxford, England.

Preparation of the Reagent.—Since the reagent turns pasty on cooling, so that an aliquot amount cannot be taken, the required quantity was separately prepared for each experiment.

To prepare 100 ml. of the reagent, 110 ml. of benzyl alcohol was mixed with a quantity of commercial potassium hydroxide containing 11.2 g. of KOH, and water was removed by distillation. To secure complete removal, distillation was continued until about 10 ml. of benzyl alcohol had been collected.

Procedure.—The usual procedure consisted in refluxing 100 ml. of the reagent with 0.1 mole of the heterocyclic component. In several instances, a separator[18] was used to remove the water formed in the reaction. After the reaction mixture had been left to cool, one-half volume of water and three volumes of ether were added; the ether solution was then separated and washed several times with water. The combined aqueous solutions were again extracted with ether which, after washing with water, was added to the main ethereal solution which was dried over sodium sulfate; the ether was distilled off on a water-bath and the benzyl alcohol removed *in vacuo*. Where the reaction product contained constituents of a boiling point lower than or close to that of benzyl alcohol, either a Vigreux fractionating column was used in the distillation of the benzyl alcohol, or else the reaction mixture was worked up altogether differently. In some experiments of prolonged reaction time, by-products such as benzyl ether and stilbene, arising from the transformation of the reagent itself, were encountered.[19] A usual by-product was potassium benzoate (arising from benzaldehyde), which precipitated during the reaction.

2-Phenethylpyridine (I).—Commercial 2-picoline was fractionated and the fraction of boiling point 125–126° was used.

2-Phenethylpyridine was obtained in 83% yield by refluxing 2-picoline with the reagent for 43 hr. The base, recovered from its picrate (m.p. 128.5–130°, lit.[4] 125.5–127° and[20] 128–129°), boiled at 164–165° (25 mm.) (lit.[4] 145–146° at 10 mm.).

2-(1,3-Diphenylisopropyl)-pyridine (II) was obtained in 15% yield by refluxing I with the reagent for 48 hr. It was purified by conversion to its picrate, which melted, after several recrystallizations from alcohol, at 140–141°, lit.[4] 136.5–137.5°. Recovered starting material amounted to 70%.

4-Phenethylpyridine (III).—4-Picoline (18.6 g., 0.2 mole) was refluxed with 200 ml. of reagent for 4 hr. The mixture was set for distillation and the fraction boiling between 90 and 180° was collected. It contained 4.35 g. of starting material, determined by precipitation as styphnate in alcoholic solution. The distillation residue was treated with water and worked up by the general procedure. The fraction boiling at 158–165° (25 mm.) gave 18.7 g. (67%) of recrystallized material, m.p. 70–70.8°, lit.[4] 70–71°; **picrate**, m.p. 168–169° (from toluene), lit.[21] 162–163°; **hydrochloride**, m.p. 181–183° (from alcohol–ether), lit.[22] 180° not sharp.

4-(1,3-Diphenylisopropyl)-pyridine (IV) was obtained by refluxing 4.6 g. (0.025 mole) of III with 25 ml. of reagent for 48 hr. After a forerun, consisting mainly of starting material, the fraction boiling at 180–210° (5 mm.) was collected. Recrystallization from petroleum ether afforded 1.2 g. (17.5%) of colorless prisms, m.p. 71.5–73°, mixed m.p. with the starting material 51–57°.

Anal. Calcd. for $C_{20}H_{19}N$: C, 87.87; H, 7.01; N, 5.12. Found: C, 88.22; H, 7.11; N, 4.79.

Picrate, yellow plates, m.p. 168–170° (from butanol). *Anal.* Calcd. for $C_{26}H_{22}N_4O_7$: C, 62.15; H, 4.41; N, 11.15. Found: C, 62.67; H, 4.75; N, 11.4.

3-Phenethylpyridine.—3-Picoline (B.D.H. Laboratory Reagent) was converted to its zinc chloride complex and recrystallized from alcohol.[23] The base recovered from the complex was purified by the method of Riethof and coworkers,[24] and the fraction b.p. 143–144° was collected.

(14) E. Späth, F. Berger and W. Kuntara, *Ber.*, **63**, 134 (1930).

(15) W. S. Johnson and B. G. Buell, THIS JOURNAL, **74**, 4517 (1952); reference 10b.

(16) W. von E. Doering and T. C. Ashner, *ibid.*, **75**, 393 (1953).

(17) E. F. Pratt and E. J. Frazza, *ibid.*, **76**, 6174 (1954).

(18) This apparatus is described in ref. 2b.

(19) For the formation of these products see M. Guerbet, *Bull. soc. chim. France*, [4] **3**, 500 (1908); A. Lachman, THIS JOURNAL, **45**, 2356 (1923).

(20) R. P. Zelinski and M. Benilda, *ibid.*, **73**, 696 (1951).

(21) B. Fels, *Ber.*, **37**, 2137 (1904).

(22) K. Friedländer, *ibid.*, **38**, 2837 (1905).

(23) J. G. Heap, W. J. Jones and J. B. Speakman, THIS JOURNAL, **43**, 1936 (1921).

(24) G. Riethof and S. G. Richards, S. A. Savitt and D. F. Othmer, *Ind. Eng. Chem., Anal. Ed.*, **18**, 458 (1946).

Picrate, m.p. 152°, lit.[25] 153°.

3-Picoline (27.9 g., 0.3 mole) was refluxed with the reagent for 48 hr. The reaction mixture was set for distillation and the fraction boiling between 90 and 190° was collected. This fraction contained 14.4 g. of starting material, determined by precipitation as the picrate in alcoholic solution. The distillation residue was treated with water and worked up by the general procedure. After distillation of the ether, the fraction boiling between 60 and 190° was collected. It contained 3.9 g. of starting material, determined as above. After distillation of the benzyl alcohol, 25.5 g., b.p. 173–178° (30 mm.), was collected, consisting mainly of benzyl ether. Treatment of this fraction with picric acid in alcoholic solution afforded 5.1 g. of a picrate mixture with a melting range of 120–140°, which was not changed appreciably by repeated recrystallization from alcohol or benzene. After several fractional crystallizations from acetone, a small quantity of yellow prisms, m.p. 150–152°, was obtained.

Anal. Calcd. for $C_{19}H_{16}N_4O_7$: C, 55.34; H, 3.91. Found: C, 55.29; H, 3.87.

Since the melting point of this substance was close to that of 4-phenethylpyridine picrate, it was feared that the phenethylpyridine formed in the reaction might arise from 4-picocoline, a possible impurity of the starting material. This possibility was ruled out by a mixed melting point determination.

2-Phenethylquinoline (VI) was obtained in 78% yield by refluxing quinaldine with the reagent for 3 hr., b.p. 189–191° (3 mm.) (lit.[26] 210° at 9 mm.) and m.p. 27.5–29°, lit.[26] 28.5–29.5°; **picrate**, m.p. 131.5–133° (from benzene), lit.[26] 131–132° cor.; **methiodide**, m.p. 192–193° (from alcohol), lit.[27] 189°.

2-Styrylquinoline (VII).—Potassium hydroxide (4.5 g.) was dissolved in 40 ml. of hot benzyl alcohol. When the solution had cooled down to about 100°, 7.2 g. of quinaldine and 10.6 g. of benzaldehyde were added and the mixture was heated at 130–140° for 5 hr. After the usual treatment the benzyl alcohol and the unreacted quinaldine were distilled *in vacuo* and at a temperature of up to 170° (25 mm.). The residue was recrystallized from a small quantity of alcohol to give 1.0 g. of VII, m.p. and mixed m.p.[28] 99–100.5°.

Reduction of VII was performed by refluxing it with the reagent for 1 hr. The fraction boiling at 170–210° (4 mm.) was converted to the picrate in benzene solution. Recrystallization from benzene or alcohol afforded 2-phenethylquinoline picrate, m.p. 128–130° and mixed m.p. 130–132°, in 40% yield.

2-Phenethyl-1,2,3,4-tetrahydroquinoline was obtained in 55% yield by refluxing VI with the reagent for 14 hr. The product was purified by conversion to the hydrochloride and recrystallization from alcohol; m.p. of the **hydrochloride** 214–217°, lit.[29] 210–211°; b.p. of the recovered base 160–161° (0.2 mm.), lit.[29] 229–230° (20 mm.); **N-benzoyl derivative,**[30] m.p. 111° (from heptane), lit.[29] 107°.

The picrate crystallizes from benzene in small, yellow prisms, m.p. 123°. *Anal.* Calcd. for $C_{23}H_{22}N_4O_7$: C, 59.22; H, 4.75. Found: C, 58.82; H, 4.98.

4-Phenethylquinoline (IX).—A mixture of 28.6 g. of lepidine, 35 ml. of benzyl alcohol and 2.5 g. of molten potassium hydroxide was refluxed in a flask equipped with a separator. The water collected amounted to 3.3 ml. The product, precipitated by the addition of water to the cold reaction mixture, was recrystallized from petroleum ether to give 25.4 g. of IX, m.p. 103–104°, lit.[4] 99.5–101°; **picrate**, m.p. 192–193°, lit.[4] 183–186°.

The aqueous filtrate was extracted with ether and the ethereal solution added to the mother liquor of the recrystallization. Fractional distillation of the mixture afforded a forerun, containing 1.5 g. of starting material, and 6.8 g. of crude IX, b.p. 195–210° (5 mm.), from which 4.6 g. of pure product was obtained by recrystallization; total yield 76.5%.

4-(1,3-Diphenylisopropyl)-quinoline (X).—A mixture of 11.6 g. (0.05 mole) of IX and 50 ml. of reagent was refluxed for 24 hr. The usual treatment afforded a forerun, containing 9.0 g. of starting material and 3.1 g., b.p. 170–210° (0.2 mm.). The latter fraction was converted to the picrate in alcoholic solution. Two recrystallizations from toluene afforded 2.0 g. (27%) of yellow prisms, m.p. 194–196°.

Anal. Calcd. for $C_{30}H_{24}N_4O_7$: C, 65.21; H, 4.38. Found: C, 65.48; H, 4.54.

The base recovered from the picrate crystallized from petroleum ether in colorless plates, m.p. 95–96°. *Anal.* Calcd. for $C_{24}H_{21}N$: C, 89.12; H, 6.55. Found: C, 89.07; H, 6.51.

2,4-Diphenethylquinoline (XII).—A mixture of 39.3 g. (0.25 mole) of 2,4-dimethylquinoline[31] and 500 ml. of reagent was refluxed in a flask equipped with a separator for 2 hr. The residue left after the usual treatment was converted in alcohol solution to the picrate, which, recrystallized from xylene, gave 105 g. (74%) of m.p. 195–200°. Another recrystallization gave yellow plates, m.p. 198–201°.

Anal. Calcd. for $C_{31}H_{26}N_4O_7$: C, 65.72; H, 4.63; N, 9.89. Found: C, 65.61; H, 4.68; N, 9.53.

The base recovered from the picrate had a b.p. of 232–234° (0.6 mm.) and crystallized from a small quantity of petroleum ether on long standing in almost colorless prisms, m.p. 54°. *Anal.* Calcd. for $C_{25}H_{23}N$: C, 88.98; H, 6.87; N, 4.15. Found: C, 89.15; H, 6.82; N, 4.02.

Styphnate, yellow-green needles, m.p. 183° (from toluene). *Anal.* Calcd. for $C_{31}H_{26}N_4O_8$: C, 63.91; H, 4.50. Found: C, 64.13; H, 4.37.

2,4-Bis-(1,3-diphenylisopropyl)-quinoline (XIV).—A mixture of 3.4 g. (0.01 mole) of XII and 10 ml. of reagent was refluxed for 46 hr. After the usual treatment, 3.2 g., b.p. 220–240° (0.1 mm.), was collected. Two recrystallizations from petroleum ether gave 0.45 g. (13%) of XIV, colorless prisms, m.p. 104°.

Anal. Calcd. for $C_{39}H_{35}N$: C, 90.48; H, 6.82; N, 2.71. Found: C, 90.36; H, 6.87; N, 2.76.

Picrate, yellow-green plates, m.p. 175.5–176.5° (from propanol).

From the mother liquors of the base, 1.7 g. of the picrate of the starting material was recovered.

2,4-Distyrylquinoline (XIII).—While the method of Fischer and co-workers,[32] who prepared this compound with zinc chloride as condensing agent, gave very poor yields, the use of acetic anhydride as condensing agent[33] proved satisfactory.

A mixture of 7.9 g. (0.05 mole) of 2,4-dimethylquinoline,[31] 11.7 g. (0.11 mole) of benzaldehyde and 10.2 g. (0.1 mole) of acetic anhydride was refluxed for 22 hr. Unchanged starting material and the acetic acid formed were removed by steam distillation. The residue was dissolved in alcohol and precipitated by an alcoholic solution of 11.5 g. of picric acid. Two recrystallizations from *o*-dichlorobenzene afforded 11.7 g. (41%) of the **picrate** of **XIII** as small yellow needles, m.p. 260–263° dec.

Anal. Calcd. for $C_{31}H_{22}N_4O_7$: C, 66.19; H, 3.94. Found: C, 65.91; H, 4.28.

M.p. of the recovered base, 119.5–120°, lit.[32] 118°.

Hydrogenation of XIII was performed in absolute alcohol, in the presence of Raney nickel at room temperature and 4 atm. pressure. Approximately two moles of hydrogen was absorbed. The product was converted to the styphnate in alcoholic solution and recrystallized from toluene, m.p. and mixed m.p. with the styphnate of XII, 182–183°.

Reaction with 1-Methylisoquinoline.—1-Methylisoquinoline was prepared by dehydrogenation[14] of 1-methyl-3,4-dihydroisoquinoline[34] in the presence of 5% palladium-on-$CaCO_3$ at 230–250°. It had a b.p. of 134–137° (22 mm.), lit.[35] 243–245° at 728 mm.; **picrate**, m.p. 231° dec., lit.[35] 233–234 cor. and[36] 224–225° dec.

(25) J. Th. Hackmann and J. P. Wibaut, *Rec. trav. chim.*, **62**, 229 (1943).

(26) F. W. Bergstrom, THIS JOURNAL, **53**, 3027 (1931).

(27) W. Borsche and O. Vorbach, *Ann.*, **537**, 22 (1939).

(28) S. Skraup and K. Böhm, *Ber.*, **59**, 1007 (1926).

(29) F. v. Grabski, *ibid.*, **35**, 1956 (1902).

(30) R. L. Shriner and R. C. Fuson, "The Systematic Identification of Organic Compounds," 3rd Ed., John Wiley and Sons, Inc., New York, N. Y., 1948, p. 88.

(31) W. R. Vaughan, *Org. Syntheses*, **28**, 49 (1948).

(32) O. Fischer with G. Scheibe, P. Merkel and R. Müller, *J. prakt. Chem.*, **100**, 86 (1919); *C. A.*, **14**, 3636 (1920).

(33) B. D. Shaw and E. A. Wagstaff, *J. Chem. Soc.*, 77 (1933).

(34) W. M. Whaley and W. H. Hartung, *J. Org. Chem.*, **14**, 650 (1949).

(35) E. Schlittler and J. Müller, *Helv. Chim. Acta*, **31**, 914 (1948).

(36) R. S. Asthana and G. S. Misra, *J. Indian Chem. Soc.*, **28**, 483 (1951); *C. A.*, **46**, 11207 (1952).

A mixture of 7.15 g. (0.05 mole) of 1-methylisoquinoline and 50 ml. of reagent was refluxed in a flask equipped with a separator for 1 hr. After the usual treatment the following fractions were collected: (a) 7.5 g., b.p. 150–180° (0.7 mm.); (b) 1.8 g., b.p. 190–230° (0.7 mm.).

Fraction a, consisting mainly of **1-phenethylisoquinoline (XV)**, was converted to the hydrochloride by addition of concd. hydrochloric acid and evaporation of the excess acid at 100° *in vacuo*. Recrystallization from benzene containing 10% of absolute alcohol afforded 5.1 g. of a very hygroscopic substance, m.p. 168–170°. The free base is a colorless liquid, b.p. 173–175° (0.7 mm.).

Anal. Calcd. for $C_{17}H_{15}N$: C, 87.15; H, 6.48; N, 6.00. Found: C, 87.48; H, 6.0; N, 5.56.

Picrate, small yellow needles, m.p. 191–193° (from xylene or butanol). *Anal.* Calcd. for $C_{23}H_{18}N_4O_7$: C, 59.74; H, 3.92. Found: C, 59.71; H, 4.10.

Fraction b gave, after two recrystallizations from petroleum ether, 0.92 g. of **1-(1,3-diphenylisopropyl)-isoquinoline (XVI)** as colorless cubes, m.p. 86°.

Anal. Calcd. for $C_{24}H_{21}N$: C, 89.12; H, 6.55; N, 4.33. Found: C, 88.98; H, 6.70; N, 4.91.

Picrate, yellow plates, m.p. 152–153° (from xylene). *Anal.* Calcd. for $C_{30}H_{24}N_4O_7$: C, 65.21; H, 4.38; N, 10.14. Found: C, 65.42; H, 4.61; N, 10.0.

The yields of XV and XVI were 37.8 and 9.2%, respectively.

When the refluxing was carried out without removal of the water formed, only 20% of XV, together with a substantial quantity of starting material, were obtained

1-Styrylisoquinoline (XVII), m.p. 111° (lit.[37] 111°), was prepared by the general procedure of Shaw and Wagstaff,[33] using acetic anhydride as condensing agent.

Hydrogenation of **XVII** was performed in absolute alcohol in the presence of 5% its weight of 5% palladium-on-charcoal at room temperature and atmospheric pressure. The oily product was converted in alcohol solution to the picrate, which was recrystallized from butanol, m.p. and mixed m.p. with the picrate of 1-phenethylisoquinoline, 191–193°.

Reaction with 3-Methylisoquinoline.—A mixture of 28.6 g. (0.2 mole) of 3-methylisoquinoline and 200 ml. of reagent was refluxed in a flask equipped with a separator for 6 hr. After the usual treatment the following fractions were collected: (a) 23.0 g., b.p. 120–210° (4 mm.); (b) 15.6 g., b.p. 240–260° (4 mm.).

Fraction a gave after two recrystallizations from heptane 5.8 g. of **3-phenethylisoquinoline (XVIII)**, clusters of colorless needles, m.p. 94–95°.

Anal. Calcd. for $C_{17}H_{15}N$: C, 87.51; H, 6.48; N, 6.00. Found: C, 87.90; H, 6.67; N, 5.85.

Picrate, small yellow needles, m.p. 161.5–163° (from toluene or butanol). *Anal.* Calcd. for $C_{23}H_{18}N_4O_7$: C, 59.74; H, 3.92; N, 12.12. Found: C, 59.87; H, 4.09; N, 11.8.

Fraction b was converted to the picrate in alcoholic solution. Recrystallization from toluene and then from butanol afforded 6.5 g. of the **picrate of 3-(1,3-diphenylisopropyl)-isoquinoline (XIX)** as yellow needles, m.p. 200–202°.

Anal. Calcd. for $C_{30}H_{24}N_4O_7$: C, 65.21; H, 4.38; N, 10.14. Found: C, 64.98; H, 4.27; N, 10.3.

The free base, colorless plates, m.p. 111° (from petroleum ether). *Anal.* Calcd. for $C_{24}H_{21}N$: C, 89.12; H, 6.55; N, 4.33. Found: C, 89.07; H, 6.68; N, 4.22.

The yields of XVIII and XIX were 12.5 and 6%, respectively.

When the reaction was carried out for 1 hr., only 12% of XVIII, together with a substantial quantity of starting material, was obtained.

3-Styrylisoquinoline (XX).—This compound was prepared by the method of Erlenmeyer and co-workers.[38] The intermediate 3-styrylisoquinoline methiodide had a m.p. of 285–287° (sealed capillary), lit.[38] 300–302 and[39] 286–287°. When another crystallization from dioxane–water was attempted, the compound decomposed with liberation of iodine. It was recrystallized from alcohol or from a mixture of Cellosolve and water, but here too slight decomposition occurred.

Anal. Calcd. for $C_{18}H_{16}NI$: I, 34.2. Found: I, 31.0, 29.9.

The instability of the compound presumably accounts for the variation in the melting points given in the literature, as well as for the low iodine content found.

Double sublimation of the methiodide at 180–200° (0.1 mm.) gave XX, m.p. 155.5–156.5° (from alcohol), lit.[38] 155–156.5°; **picrate**, m.p. 250–251° (from xylene or butanol), lit.[38] 258–259°.

Hydrogenation of **XX** was performed in ethyl acetate solution in the presence of 5% palladium-on-charcoal at room temperature and 4 atm. pressure; m.p. and mixed m.p. with 3-phenethylisoquinoline, 94–95° (from hexane); **picrate**, m.p. and mixed m.p. 161–163°.

Acridane.—A mixture of 9.0 g. (0.05 mole) of acridine and 25 ml. of reagent was refluxed for 30 minutes. A copious precipitate of potassium benzoate appeared immediately after the beginning of boiling. The product crystallized on the addition of water to the cold reaction mixture; yield 7.7 g. (84%), m.p. 160–164°. Recrystallization from alcohol gave 5.6 g., m.p. 174–175°, lit.[40] 170°.

Reaction with Quinoline. (1) 3-Benzyl-1,2,3,4-tetrahydroquinoline (XXV) (Long Reaction Time).—A mixture of 32.2 g. (0.25 mole) of quinoline and 250 ml. of reagent was refluxed for 5 hr. After the usual treatment, the benzyl alcoholic fraction, collected at a temperature of up to 180° (30 mm.), was kept for further treatment (see below). The residue was recrystallized from alcohol and then from heptane to yield 20.5 g. of XXV, colorless prismatic plates, m.p. 80–81°, b.p. 184–187° (3 mm.). An analytical sample melted at 80.5–81.5°.

Anal. Calcd. for $C_{16}H_{17}N$: C, 86.05; H, 7.67; N, 6.27. Found: C, 86.10; H, 7.60; N, 6.80.

From the mother liquors of recrystallization 3.3 g., m.p. 80–81°, was recovered by distillation and recrystallization, raising the total yield of XXV to 23.8 g. (42.5%).

The following derivatives of XXV have been prepared: **the hydrochloride**, obtained by treatment of the base with dilute hydrochloric acid and recrystallization from very dilute hydrochloric acid or alcohol–ether, colorless needles, m.p. 215–218°.

Anal. Calcd. for $C_{16}H_{18}NCl$: Cl, 13.7. Found: Cl, 13.9.

Picrate, small yellow needles, m.p. 158–161° (from alcohol or benzene). *Anal.* Calcd. for $C_{22}H_{20}N_4O_7$: C, 58.40; H, 4.46; N, 12.39. Found: C, 58.30; H, 4.38; N, 12.4.

N-Acetyl derivative, prepared by refluxing 1 g. of the base with 10 ml. of acetic anhydride and 2 g. of anhydrous sodium acetate for 2 hr., b.p. 197–200° (4 mm.), colorless plates, m.p. 65–66° (from heptane).

Anal. Calcd. for $C_{18}H_{19}NO$: C, 81.47; H, 7.22; CH_3CO, 16.2. Found: C, 81.73; H, 7.08; CH_3CO, 15.9.

The base was dehydrogenated in the presence of 2% palladium-on-$BaSO_4$ for 3 hr. at 300°. The residue obtained from the filtered ethereal solution is **3-benzylquinoline (XXIV)**, m.p. and mixed m.p.[9] 67–68° (from a small quantity of heptane); **picrate**, m.p. and mixed m.p.[9] 180–182° (from alcohol and then from xylene).

From the benzyl-alcoholic fraction **1,2,3,4-tetrahydroquinoline (XXII)** was separated by dilution with ether and extraction with 10% hydrochloric acid. The base recovered from the acid solution was precipitated as its hydrochloride with dry hydrogen chloride in ethereal solution. Recrystallization from absolute alcohol gave 4.4 g. (10.5%), m.p. and mixed m.p.[41] 184–186°; **picrate**, m.p. and mixed m.p.[42] 144–145°.

(2) 3-Benzylquinoline (XXIV) (Short Reaction Time).—A mixture of 32.2 g. (0.25 mole) of quinoline, 125 ml. of reagent and 125 ml. of benzyl alcohol was refluxed for 10 minutes. After the usual treatment the fraction boiling at 170–190° (3 mm.) was collected. Two recrystallizations from a small quantity of heptane gave 2.7 g. (5%), m.p. and mixed m.p.[9] 67–68°.

Reduction of XXIV.—(1) Reduction by the reagent was performed by refluxing 2.2 g. (0.01 mole) of XXIV and 10 ml. of reagent for 1 hr. A bulky precipitate of potassium benzoate appeared. After the usual treatment the fraction boiling at 170–190° (3 mm.) was collected. Recrystalliza-

(37) W. H. Mills and J. L. B. Smith, *J. Chem. Soc.*, **121**, 2724 (1922).

(38) H. Erlenmeyer, H. Baumann and E. Sorkin, *Helv. Chim. Acta*, **31**, 1978 (1948).

(39) L. G. S. Brooker and F. L. White, THIS JOURNAL, **73**, 1094 (1951).

(40) W. Schlenk and E. Bergmann, *Ann.*, **463**, 281 (1928).

(41) L. Hoffmann and W. Königs, *Ber.*, **16**, 727 (1883).

(42) M. Ehrenstein and W. Bunge, *ibid.*, **67**, 1715 (1934).

tion from alcohol gave 1.6 g. (73%) of XXV, m.p. and mixed m.p. 80–81°.

(2) Catalytic hydrogenation was carried out in absolute alcohol solution in the presence of Raney nickel at 50–60° and 4 atm. pressure. The catalyst was filtered and washed with ether, the combined solutions were evaporated and the residue was recrystallized from alcohol to afford XXV in 90% yield, m.p. and mixed m.p. 80–81°.

3-Methyl-1,2,3,4-tetrahydroquinoline.—A mixture of 1.3 g. (0.01 mole) of 3-methylquinoline[43] (b.p. 140–142° at 25 mm.) and 10 ml. of reagent was refluxed for 5 hr. Ether and water were added to the cold mixture, the organic layer was washed with water and then extracted with dilute hydrochloric acid. The base (0.8 g.) recovered from the acid solution was dissolved in alcohol and precipitated with an alcoholic solution of 1.5 g. of picric acid. The precipitate (0.15 g.) was identified as the picrate of the starting material, m.p. and mixed m.p.[43] 185–186°.

The alcoholic mother liquor was evaporated and the residue recrystallized from toluene to afford 0.76 g. of 3-methyl-1,2,3,4-tetrahydroquinoline picrate, m.p. 155–156°, lit.[44] 155°.

Decomposition of the picrate gave the free base, whose N-benzoyl derivative,[30] recrystallized twice from dilute alcohol, melted at 88°, lit.[44] 84°.

3-Phenyl-1,2,3,4-tetrahydroquinoline.—A mixture of 5.2 g. (0.025 mole) of 3-phenylquinoline[9] (m.p. 50.5–52°) and 50 ml. of reagent was refluxed for 24 hr. After the usual treatment, the residue was recrystallized twice from alcohol or heptane to give 2.6 g., m.p. 88.5°, lit.[45] 83°, b.p. 177–179° (4 mm.).

Anal. Calcd. for $C_{15}H_{15}N$: C, 86.08; H, 7.22. Found: C, 85.94; H, 7.11.

An additional quantity of the base in the form of its hydrochloride (1.4 g.) was recovered by evaporation of the mother liquors and treatment of the residue with hydrogen chloride in ethereal solution; m.p. 224–227° (from alcohol–ether), lit.[45] 229°, total yield 72.5%.

N-Benzoyl derivative,[30] colorless needles, m.p. 140–141° (from methanol). *Anal.* Calcd. for $C_{22}H_{19}NO$: C, 84.31; H, 6.11. Found: C, 84.52; H, 6.06.

Dehydrogenation of the base with 5% palladium-on-charcoal at 250° gave the starting material.

3-Benzylcarbostyryl.—Water was distilled from a mixture consisting of 5.8 g. (0.04 mole) of carbostyryl[46] (m.p. 199–201°), 4.0 g. of potassium hydroxide and 50 ml. of benzyl alcohol. The operation was terminated by the distillation of 5 ml. of benzyl alcohol. The anhydrous mixture was then refluxed for 22 hr. Ether and water were added to the cold reaction mixture, whereupon part of the product precipitated. It was filtered and recrystallized from benzene to give 1.5 g. of colorless needles, m.p. 199–200°, mixed m.p. with the starting material 140–165°.

Anal. Calcd. for $C_{16}H_{13}NO$: C, 81.68; H, 5.57. Found: C, 81.38; H, 5.32.

The ether–water filtrate was worked up in the usual manner. The residue from the ethereal layer was extracted with 200 ml. of boiling water to give 0.6 g. of the starting material. The water-insoluble residue gave on recrystallization 1.8 g. of 3-benzylcarbostyryl. The aqueous layer was acidified to congo red with hydrochloric acid to precipitate some benzoic acid. Addition of an excess of sodium acetate to the filtrate precipitated 0.6 g. of starting material, total yield 45%.

Conversion of 3-Benzylcarbostyryl to 3-Benzylquinoline.—Refluxing 3-benzylcarbostyryl with five parts of $POCl_3$[47] for 3 hr. afforded **3-benzyl-2-chloroquinoline** in 80% yield as colorless prisms, m.p. 74–75° (from petroleum ether).

Anal. Calcd. for $C_{16}H_{12}NCl$: Cl, 14.0. Found: Cl, 13.9.

Dechlorination was effected with powdered aluminum in dilute acetic acid, a method used by Rabe and co-workers[48] in the case of 2-chloro-6-methoxylepidine. The product was identified as 3-benzylquinoline, m.p. and mixed m.p. 65–67°

4-Benzylisoquinoline (XXVI).—A mixture of 25.8 g. (0.2 mole) of isoquinoline, 33 g. of benzyl alcohol and 2.5 g. of molten potassium hydroxide was refluxed in a flask equipped with a separator for 90 minutes. The water collected amounted to 3.2 ml. Water was added to the cold reaction mixture and the precipitated product was recrystallized twice from heptane to give 20.5 g. of XXVI, m.p. 119–120°, lit.[13] 119°; **picrate**, m.p. 195–196°, lit.[49] 190–191° and[50] 195°; **methiodide**, m.p. 195.5–197.5°, lit.[51] 188°.

The aqueous filtrate of the crude base was extracted with ether, the ethereal solution combined with the mother liquors of recrystallization and the solvents were evaporated. Fractionation yielded a forerun, containing 4 g. of the starting material, and a fraction, b.p. 150–200° (4 mm.), containing 1.5 g. of XXVI. The distillation residue was dissolved in alcohol and precipitated by an alcoholic solution of picric acid to afford, after recrystallization from chlorobenzene, 2.9 g. of **the picrate** of **1,2-diphenyl-2-(4′-isoquinolyl)-ethane (XXVII)** as yellow needles, m.p. 203–204°.

Anal. Calcd. for $C_{29}H_{22}N_4O_7$: C, 64.68; H, 4.12. Found: C, 64.75; H, 4.35.

The base recovered from the picrate boiled at 180° (0.05 mm.) and crystallized from heptane in colorless plates, m.p. 103–104.5°.

Anal. Calcd. for $C_{23}H_{19}N$: C, 89.28; H, 6.19. Found: C, 89.55; H, 6.34.

The yields of XXVI and XXVII were 59.5 and 3.2%, respectively.

1,2-Diphenyl-2-(4′-isoquinolyl)-ethane (XXVII).—A mixture of 11.0 g. (0.05 mole) of XXVI and 50 ml. of reagent was refluxed in a flask equipped with a separator for 7 hr. After the usual treatment 8.3 g., b.p. 170–200° (0.2 mm.), was collected. Treatment with picric acid in alcohol solution gave 4.9 g. (26%) of the picrate of XXVII, m.p. 203–204°. Some starting material (3.2 g.) was recovered from the forerun.

Experiments with 3,4-Dihydroisoquinoline.—3,4-Dihydroisoquinoline was liberated from its picrate, prepared by the method of Snyder and Werber.[52] The free base is a colorless oil, b.p. 122–123° (25 mm.).[53]

Anal. Calcd. for C_9H_9N: C, 82.40; H, 6.92. Found: C, 82.77; H, 6.75.

(1) **Reaction with the Reagent.**—A mixture of 6.5 g. (0.05 mole) of 3,4-dihydroisoquinoline and 50 ml. of reagent was refluxed for 30 minutes. The fraction (2.2 g.) boiling at 170–190° (5 mm.) was recrystallized from heptane to give a product melting at 118–119°, mixed m.p. with 4-benzylisoquinoline 119–120°. The identity was also checked by a mixed melting point determination of the picrates.

(2) **Reaction with Benzaldehyde.**—A stirred mixture of 1.3 g. of 3,4-dihydroisoquinoline, 1.5 g. of benzaldehyde, 10 ml. of benzyl alcohol and 0.8 g. of molten potassium hydroxide was heated at 110–120° for 30 minutes. After the usual treatment the residue was fractionated to give a forerun, containing 0.45 g. of starting material, determined as its picrate, and 0.4 g., b.p. 180–200° (4 mm.), which afforded 0.23 g. of recrystallized 4-benzylisoquinoline, m.p. and mixed m.p. 118–119°. No 4-benzylisoquinoline could be isolated in a parallel experiment in which benzaldehyde was omitted.

Attempted Reactions.—Pyridine was recovered unchanged after heating with the reagent in an autoclave at 250–280° for 30 hr. Similarly, no transformation products of 2-phenylpyridine[54] and 2-phenylquinoline[55] could be detected when these compounds were refluxed with the reagent for 45 hr.

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