Reactions of 4-Aminocycloheptimidazoles with Alkyl Iodides, Acyl Chlorides, and α-Haloketones

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The reactions of 4-amino-2-phenylcycloheptimidazole with alkyl iodides and α-bromoketones gave respectively 1-alkyl- and 1-acetonyl- (or 1-phenacyl)-substituted cycloheptimidazol-4(1*H*)-ones, while the reactions with acyl chlorides gave 4-arylamino-2-phenylcycloheptimidazoles. On the other hand, 2,4-diaminocycloheptimidazole were benzoylated with benzoyl chloride on the amino group at the 2- and/or 4-position and reacted with α-haloketones to give tricyclic 2-substituted 9-aminocyclohept[*d*]imidazo[1,2-*a*]imidazoles.

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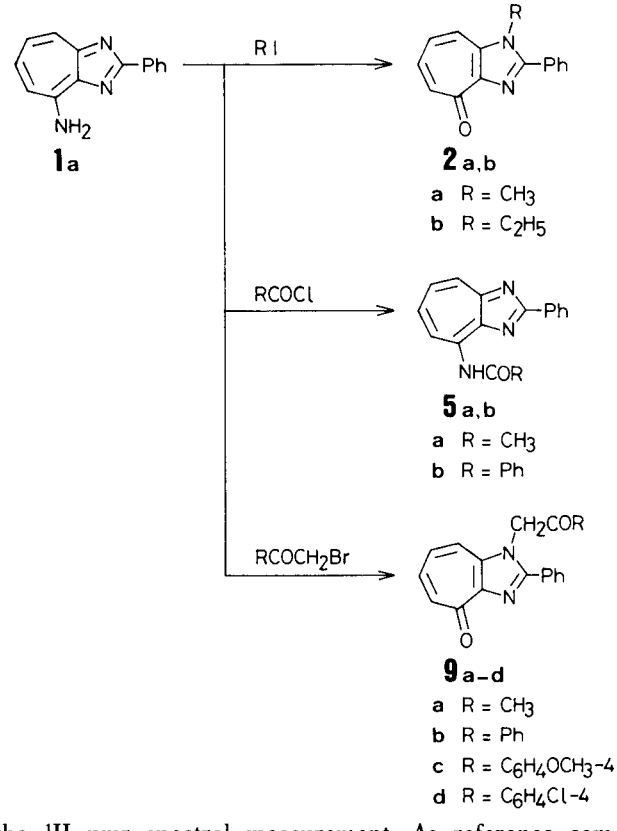
In a previous paper [2], we reported synthesis of some 4-aminocycloheptimidazoles (4-amino-1,3-diazaazulenes). These cycloheptimidazoles are expected to be useful precursors to polyheterocycle-fused compounds, because they have a reactive amino group at the 4-position near to the nitrogen atom in the imidazole ring. For example, it was reported that 8-amino-3-phenylcyclohepta[*b*]pyrrole reacted with phenacyl bromide to afford 1,3- and 1,4-diphenyl-2a,5-diazacyclohept[*cd*]indene [3], while 8-hydrazino-3-phenylcyclohepta[*b*]pyrrole was cyclized with triethyl orthoformate to give 1-phenyl-2a,4,5-triazabenz[*cd*]-azulene [4]. Thus, we carried out several reactions of 4-aminocycloheptimidazoles in order to clarify the chemical properties and to prepare the heterocycle-fused seven-membered conjugated compounds.

Scheme 1



Results and Discussion.

Reactions with Alkyl Iodides.

4-Aminocycloheptimidazoles have three reactive sites for the nucleophiles. When a solution of 4-amino-2-phenylcycloheptimidazole (**1a**) and methyl iodide in tetrahydrofuran was heated for 100 hours at 50°, 1-methyl-2-phenylcycloheptimidazol-4(1*H*)-one (**2a**) was isolated in 30% yield. The structure of the product **2a** was assigned on its elemental analysis ($C_{15}H_{12}N_2O$) and spectral data. In the ir spectrum, the amino absorption band was not observed but the tropone carbonyl absorption band was observed. This means that the amino group was hydrolyzed to the tropone carbonyl group. The presence of the carbonyl group was also confirmed from the mass spectral fragmentation.

The position of the introduced methyl group was determined from the comparison of its chemical shift and the effect of shift reagent to those of reference compounds in the ^1H nmr spectral measurement. As reference compounds, 3-methylcycloheptimidazol-4(3*H*)-one (**3**) and 1,3-dimethylcycloheptapyrazol-8(1*H*)-one (**4**) [5] were employed.

The effect of the shift reagent [Eu(fod)$_3$] on the methyl signal was evaluated as Δδ values. These results are summarized in Table 1. The Δδ value (0.65) for the product **2a** is approximately closer to that (0.24) for the 3-methyl

3 **4**

Figure 1

group of compound **4** than those (1.30 and 1.31) for the 1-methyl group of compounds **3** and **4**.

Table 1
Effect of Shift Reagent [a]

Compound		δ_A	δ_B	$\Delta\delta$
2a	3-CH_3	3.85	4.50	0.65
3	1-CH_3	4.20	5.51	1.31
4	1-CH_3	4.39	5.69	1.30
	3-CH_3	2.50	2.74	0.24

[a] δ_A Measurement without Eu $(fod)_3$. δ_B Measurement in the presence of 10% $EU(fod)_3$.

The reactions of compound **1a** with ethyl iodide was carried out under refluxing for 48 hours to give 1-ethyl-2-phenylcycloheptimidazol-8(1*H*)-one (**2b**) in 12% yield.

Reactions with Acyl Chlorides.

A solution of compound **1a** and acetyl chloride in tetrahydrofuran was heated at 50° for 12 hours in the presence of potassium carbonate to afford 4-acetamido-2-phenylcycloheptimidazole (**5a**) in 34% yield. The structure of product **5a** was confirmed from its elemental analysis ($C_{16}H_{13}N_3O$) and spectral data. The ir spectrum shows the NH absorption at 3340 cm^{-1} and the carbonyl absorption at 1710 cm^{-1}. In the ^1H nmr spectrum, the amido NH proton was observed at δ 10 and the 5-H proton shifted to very low field (δ 9.5). Compound **1a** also reacted with benzoyl chloride to give 4-benzamido-2-phenylcycloheptimidazole (**5b**) in 41% yield.

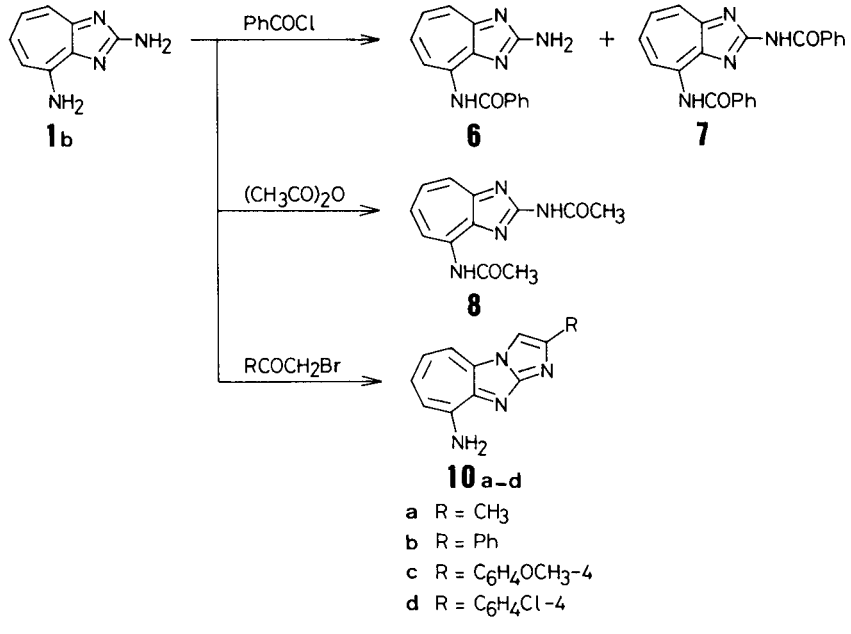
The reaction of 2,4-diaminocycloheptimidazole (**1b**) and benzoyl chloride in tetrahydrofuran was carried out under refluxing for 2 hours in the presence of potassium carbonate gave 2-amino-4-benzamino- (**6**) and 2,4-bis(benzamido)-cycloheptimidazole (**7**) in 25 and 8% yields, respectively. Their structures were confirmed from the elemental analyses and spectral data. Product **6** showed a molecular ion peak at m/z 264 in the mass spectrum. The ^1H nmr spectrum showed exchangeable protons in deuterium oxide at δ 6.7 (2H for NH_2) and 10.2 (1H for NH). The signal for the 5-H proton shifted to very low field (δ 9.5). This means that the amino group at the 4-position was benzoylated. It was found from the mass spectrum, m/z 368 (M^+), that product **7** was doubly benzoylated compound. The ^1H nmr spectrum showed the 5-H proton at δ 9.6 and the 4-NH proton at δ 10.3. However, the 2-NH proton overlapped with aromatic protons so that it was not assigned.

The diamino compound **1b** reacted with acetic anhydride to afford diacylated product, 2,4-bis(acetamido)cycloheptimidazole (**8**) in 67% yield, which was identified from the elemental analysis and spectral data.

Reactions with α-Bromo Ketones.

When a solution of 4-amino-2-phenylcycloheptimidazole (**1a**) and bromoacetone in acetonitrile was refluxed for 24 hours, 1-acetonyl-2-phenyl-1,4-dihydrocycloheptimidazol-4-one (**9a**) was obtained in 17% yield. It was suggested

Scheme 2



that the reaction took place at the 1-position and the 4-amino group was hydrolyzed. Its structure was determined from its elemental analysis ($C_{17}H_{14}N_2O_2$) and spectral data. The ir spectrum showed two carbonyl absorptions at 1723 and 1622 cm^{-1}. These were assigned to the acetonyl and the tropone carbonyl group, respectively. In the ^1H nmr spectrum, the typical CH_2 signal was observed at δ 5.07.

The reaction of imidazole **1a** with phenacyl bromide gave 1-phenacyl-2-phenylcycloheptimidazol-4(1*H*)-one (**9b**) in 13% yield. 4-Methoxy- and 4-chlorophenacyl bromides reacted to afford 1-(4-methoxyphenacyl)- (**9c**) and 1-(4-chlorophenacyl)-2-phenylcycloheptimidazol-4(1*H*)-one (**9d**) in 12 and 14% yield, respectively. It might be attributed to hydrogen-bonding in the **1b'** form and tautomerism between the **1b** and **1b'** forms that the reaction at the 4-NH_2 group was not observed. This is peculiar in contrast with 5-amino- [6] and 6-aminocycloheptimidazoles [7].

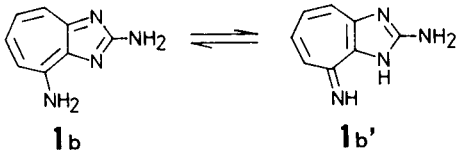


Figure 2

Furthermore, the reaction of 2,4-diaminocycloheptimidazole (**1b**) with bromoacetone was carried out to afford 9-amino-2-methylcyclohept[*d*]imidazo[1,2-*a*]imidazole (**10a**) in good yield (80%). Its structure was confirmed from its elemental analysis ($C_{11}H_{10}N_4$) and spectral data. The ir spectrum showed only the NH absorption as typical band. In the ^1H nmr spectrum, the CH_3 and NH_2 signals were observed at δ 2.33 and 8.1, respectively. In a similar manner, the reactions with phenacyl bromides gave the corresponding 9-amino-2-phenylcyclohept[*d*]imidazo[1,2-*a*]imidazoles **10b-d** in 73, 62, and 74% yields, respectively.

Thus, it was found that 2,4-diaminocycloheptimidazole (**1b**) was reacted as 2-aminocycloheptimidazole but the 4-NH_2 group was unreactive with α-bromoketones. Previously, it was reported that 2-aminocycloheptimidazole [8,9] and 2-aminocyclohepta[*b*]pyrrole [9] reacted with phenacyl bromide to afford 2-phenylcyclohept[*d*]imidazo[1,2-*a*]imidazole and 2-phenylcyclohepta[*d*]pyrrolo[1,2-*a*]imidazole, respectively.

Molecular Orbital Consideration.

Since it was found that the reactions of 4-aminocycloheptimidazole with various reagents took place at the ring-nitrogen atom or at the 4-amino group, molecular orbital treatment was carried out by using static models. As molecular orbital calculations of cycloheptimidazoles, there is only one example by Kon in 1954 [10].

For cycloheptimidazole bearing an amino group, four isomers are possible. Of them, 2- [11], 5- [6], and 6-amino-substituted isomers [7] have been reported. Very recently, some of 4-aminocycloheptimidazoles have been prepared [2]. However, the parent compound, 4-aminocycloheptimidazole, has not been obtained. On the other hand, these amino-substituted cycloheptimidazoles might exist as tautomeric mixtures between amino form and imino form. From the calculations of heat of formation of each amino-substituted cycloheptimidazoles by MNDO and MINDO/3 method, it was found that the imino forms are more stable than the amino forms in all of aminocycloheptimidazoles by 8-14 kcal/mol [12].

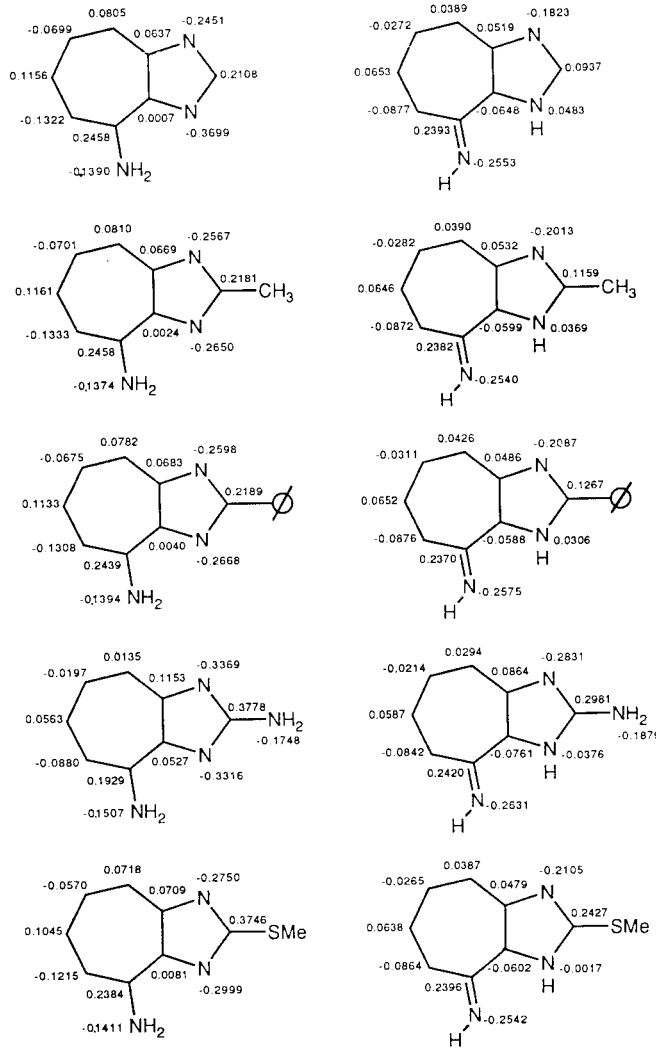


Figure 3

The net-charges by the MNDO calculation for both the amino and imino forms of some of 4-aminocycloheptimidazoles are shown in Figure 3. In the amino forms, the net-charges on the 4-amino group are negatively smaller than those on the ring-nitrogen atom at the 1- and 3-positions. The values on the 1-nitrogen atom are nearly equal to those on the 3-nitrogen atom. On the other hand, in the

imino forms, the net-charges on the nitrogen atom at the 1-position and the 4-amino group are negatively large and these results agree with the experimental facts. Unfortunately, the difference of the attacking position of the reagents is not derived from these results. In order to clarify them, properties of the reagents might be considered in the calculations.

EXPERIMENTAL

The melting points were determined with a Yanagimoto MP-S2 apparatus and are uncorrected. The ir spectra were taken on a JASCO A-102 spectrophotometer and the uv spectra on a Hitachi 200-20 spectrophotometer. The ^{1}H nmr spectra were recorded with a JEOL JNM—PMX60SI spectrometer (60 MHz). The mass spectra were obtained with a JEOL JMS-01-SG2 apparatus.

Reaction of 4-Amino-2-phenylcycloheptimidazole (**1a**) with Methyl Iodide.

To a stirred solution of the compound **1a** (218 mg, 1.0 mmole) in dry tetrahydrofuran (20 ml) was added methyl iodide (1 ml). The stirring was continued for 100 hours at 50°. After adding potassium carbonate (303 mg, 2.2 mmoles) and water (10 ml), the mixture was refluxed for 30 minutes. The solvent was removed off and the residue was triturated with water and extracted with chloroform. The evaporation residue was chromatographed on a Wakogel B-10 plate (30 x 30 cm) with ethyl acetate. The upper fraction gave the compound **1a** (21 mg, 10%). The lower fraction was recrystallized from benzene-hexane to afford 1-methyl-2-phenylcycloheptimidazol-4(1*H*)-one (**2a**) as yellow needles, yield 70 mg (30%), mp 90-91°; ir (chloroform): ν max 1625 cm^{-1} (C=O); uv (methanol): λ max 228 (log ϵ 4.40), 248 (4.45), 298 (3.70), 307 (3.72), 367 nm (3.96); ^{1}H nmr (deuteriochloroform): δ 3.85 (3H, s, CH_3), 6.6-7.9 (9H, m); ms: m/z (%) 236 (M^+, 100), 208 (M^+-CO, 31).

Anal. Calcd. for $C_{15}H_{12}N_2O$: C, 76.25; H, 5.12; N, 11.86. Found: C, 75.98; H, 5.16; N, 11.63.

Reaction of Compound **1a** with Ethyl Iodide.

A solution of compound **1a** (212 mg, 1.0 mmole) and ethyl iodide (1 ml) in tetrahydrofuran (20 ml) was refluxed for 48 hours. After adding potassium carbonate (254 mg, 1.9 mmoles) and water (10 ml), the mixture was refluxed for 30 minutes and worked up, as mentioned above. The upper fraction in the tlc gave the compound **1a** (150 mg, 71%). The lower fraction was recrystallized from benzene-hexane to afford 1-ethyl-2-phenylcycloheptimidazol-4-one (**2b**) as yellow needles, yield 28 mg (12%), mp 147-148°; ir (chloroform): ν max 1628 cm^{-1} (C=O); uv (methanol): λ max 227 (log ϵ 4.50), 243 (4.53), 292 (3.86), 306 (3.88), 359 nm (4.06); ^{1}H nmr (deuteriochloroform): δ 1.44 (3H, t, J = 7.0 Hz, CH_3), 4.83 (2H, q, J = 7.0 Hz, CH_2), 6.6-7.9 (9H, m); ms: m/z (%) 250 (M^+, 100), 222 (M^+-CO, 32), 221 (M^+-C_2H_5, 61).

Anal. Calcd. for $C_{16}H_{14}N_2O$: C, 76.77; H, 5.64; N, 11.19. Found: C, 76.59; H, 5.68; N, 11.15.

Methylation of Cycloheptimidazol-4(3*H*)-one.

To a solution of cycloheptimidazol-4(3*H*)-one (66 mg, 0.5 mmole) in chloroform (10 ml) was added the ethereal solution of diazomethane. The mixture was allowed to stand overnight. The evaporation residue was chromatographed on a Wakogel B-10 plate (20 x 20 cm) with ethyl acetate and recrystallized from benzene-hexane to afford 3-methylcycloheptimidazol-4(3*H*)-one (**3**) as pale yellow needles, yield 62 mg (86%), mp 131-132°; ir (chloroform): ν max 1630 cm^{-1} (C=O); uv (methanol): λ max 238 (log ϵ 4.39), 292 (3.74), 304 (3.79), 338 (3.71), 352 nm (3.71); ^{1}H nmr (deuteriochloroform): δ 4.20 (3H, s, CH_3), 6.9-7.9 (4H, m), 7.83 (1H, s, 2-H).

Anal. Calcd. for $C_9H_8N_2O$: C, 67.48; H, 5.03; N, 17.49. Found: C, 67.50; H, 5.18; N, 17.49.

Reaction of Compound **1a** with Acetyl Chloride.

To a solution of the compound **1a** (207 mg, 0.9 mmole) in dry tetrahydrofuran (20 ml) were added potassium carbonate (847 mg, 6.1 mmoles) and acetyl chloride (0.5 ml). The mixture was stirred for 12 hours at 50° and worked up, as mentioned above. The lower fraction on tlc gave compound **1a** (128 mg, 62%). The upper fraction was recrystallized from benzene-hexane to afford 4-acetamido-2-phenylcycloheptimidazole (**5a**) as yellow prisms, yield 83 mg (34%), mp 129-130°; ir (chloroform): ν max 3340 (NH), 1710 cm^{-1} (C=O); uv (methanol): λ max 271 (log ϵ 4.54), 361 (4.30), 419 nm (4.08); ^{1}H nmr (deuteriochloroform): δ 2.44 (3H, s, CH_3), 7.8 (3H, m, 3'-, 4'-, 5'-H), 7.8-8.4 (2H, m, 6-, 7-H), 8.4-8.8 (3H, m, 2'-, 6'-, 8-H), 9.2-9.5 (1H, m, 5-H), 10.4 (1H, br, NH); ms: m/z (%) 263 (M^+, 38), 248 (M^+-CH_3, 100).

Anal. Calcd. for $C_{16}H_{13}N_3O$: C, 72.99; H, 4.98; N, 15.96. Found: C, 73.15; H, 4.81; N, 16.01.

Reaction of the Compound **1a** with Benzoyl Chloride.

A solution of the compound **1a** (223 mg, 1.0 mmole) and benzoyl chloride (0.5 ml) in dry tetrahydrofuran (20 ml) was refluxed for 3 hours in the presence of potassium carbonate (694 mg, 5.1 mmoles). The mixture was worked up, as mentioned above, chromatographed, and recrystallized from benzene-hexane to afford 4-benzamido-2-phenylcycloheptimidazole (**5b**) as yellow prisms, yield 153 mg (47%), mp 217-218°; ir (chloroform): ν max 3340 (NH), 1690 nm (C=O); uv (methanol): λ max 274 (log ϵ 4.48), 364 (4.22), 422 nm (4.19); ^{1}H nmr (deuteriochloroform): δ 7.2-8.3 (10H, m), 8.3-8.8 (3H, m), 9.4-9.7 (1H, m, 5-H), 10.3 (1H, br, NH); ms: m/z (%) 325 (M^+, 99), 297 (M^+-CO, 49), 248 (M^+-Ph, 100).

Anal. Calcd. for $C_{21}H_{15}N_3O$: C, 77.52; H, 4.65; N, 12.92. Found: C, 77.81; H, 4.71; N, 12.72.

Reaction of 2,4-Diaminocycloheptimidazole (**1b**) with Benzoyl Chloride.

A solution of the compound **1b** (83 mg, 0.5 mmole) and benzoyl chloride (79 mg, 0.6 mmole) in tetrahydrofuran (10 ml) was refluxed for 2 hours in the presence of potassium carbonate (138 mg, 1.0 mmole). After removal of the solvent, the residue was triturated with water and extracted with chloroform. The evaporation residue was chromatographed on a Wakogel B-10 plate (30 x 30 cm) with ethyl acetate. The lower fraction was recrystallized from benzene-hexane to afford 2-amino-4-benzamidocycloheptimidazole (**6**) as yellow prisms, yield 34 mg (25%), mp 189°; ir (chloroform): ν max 1685 cm^{-1} (C=O); uv (methanol): λ max 267 (log ϵ 4.49), 303 (4.10), 368 (4.12), 390 nm (sh, 4.01); ^{1}H nmr (deuteriochloroform): δ 6.7 (2H, br, NH_2), 7.3-8.4 (8H, m), 9.4-9.6 (1H, m, 5-H), 10.2 (1H, br, NH); ms: m/z (%) 264 (M^+, 100), 236 (M^+-CO, 96).

Anal. Calcd. for $C_{15}H_{12}N_4O$: C, 68.17; H, 4.58; N, 21.20. Found: C, 68.26; H, 4.61; N, 21.03.

The upper fraction was recrystallized from benzene-hexane to afford 2,4-bis(benzamido)cycloheptimidazole (**7**) as pale yellow

prisms, yield 15 mg (8%), mp 195-196°; ir (chloroform): ν max 1693 cm^{-1} (C=O); uv (methanol): λ max 269 (log ε 4.31), 350 (3.77), 408 nm (3.78); ^1H nmr (deuteriochloroform): δ 7.1-8.1 (14H, m), 9.5-9.8 (1H, m, 5-H), 10.3 (1H, br, NH); ms: m/z (%) 368 (M^+, 8), 325 (M^+-CONH, 27).

Anal. Calcd. for $C_{22}H_{16}N_4O_2$: C, 71.72; H, 4.38; N, 15.21. Found: C, 71.72; H, 4.55; N, 15.06.

Reaction of the Compound **1b** with Acetic Anhydride.

A solution of the compound **1b** (160 mg, 1.0 mmole) in acetic anhydride (5 ml) was refluxed for 1 hour. The mixture was triturated with water, neutralized with sodium hydrogencarbonate solution, and extracted with chloroform.

The evaporation residue was recrystallized from methanol to afford 2,4-bis(acetamido)cycloheptimidazole (**8**) as pale yellow prisms, yield 164 mg (67%), mp 290-293° dec; ir (potassium bromide): ν max 1703 (C=O), 1678 cm^{-1} (C=O); uv (methanol): λ max 263 (log ε 4.39), 281 (sh, 4.14), 351 (4.06), 404 nm (3.77); ^1H nmr (deuteriochloroform + trifluoroacetic acid): δ 2.54 (3H, s, CH_3), 2.60 (3H, s, CH_3), 8.3-9.0 (3H, m), 9.7-10.2 (1H, m, 5-H).

Anal. Calcd. for $C_{12}H_{12}N_4O_2$: C, 59.01; H, 4.95; N, 22.94. Found: C, 58.81; H, 5.02; N, 22.88.

Reactions of the Compound **1a** with Bromoacetone or Phenacyl Bromides.

General Procedure.

A solution of the compound **1a** (220 mg, 1.0 mmole) and bromoacetone (0.2 ml) or phenacyl bromide (2.0 mmoles) in acetonitrile (10 ml) was refluxed for 24 hours. After adding potassium carbonate (415 mg, 3.0 mmoles) and water (10 ml), the heating was continued for 30 minutes under refluxing. The acetonitrile was evaporated off and the residue was triturated with water and extracted with chloroform. The evaporation residue from the extract was chromatographed on a Wakogel B-10 plate (30 x 30 cm) with ethyl acetate. The upper fraction gave the compound **1a**. The lower fraction was recrystallized from ethanol-hexane to afford 1-acetylmethyl- (**9a**) or 1-phenacyl-2-phenylcycloheptimidazol-4(1*H*)-ones **9b-d**.

1-Acetonyl-2-phenylcycloheptimidazol-4(1*H*)-one (**9a**).

This compound was obtained from the reaction with bromoacetone in a yield of 44 mg (17%) as yellow prisms, mp 179-180°; ir (chloroform): ν max 1723 (C=O), 1627 cm^{-1} (C=O); uv (methanol): λ max 230 (sh, log ε 4.47), 244 (4.51), 295 (3.79), 301 (3.81), 360 nm (4.03); ^1H nmr (deuteriochloroform): δ 2.27 (3H, s, CH_3), 5.07 (2H, s, CH_2), 6.8-7.4 (4H, m), 7.48 (5H, s, Ph); ms: m/z (%) 278 (M^+, 100), 235 (M^+-$COCH_3$, 50).

Anal. Calcd. for $C_{17}H_{14}N_2O_2$: C, 73.36; H, 5.07; N, 10.07. Found: C, 73.12; H, 5.23; N, 9.98.

Compound **1a** was also recovered in a yield of 74 mg (35%).

1-Phenacyl-2-phenylcycloheptimidazol-4(1*H*)-one (**9b**).

This compound was obtained from the reaction with phenacyl bromide in a yield of 46 mg (13%) as yellow prisms, mp 234-235°; ir (chloroform): ν max 1723 (C=O), 1622 cm^{-1} (C=O); uv (methanol): λ max 230 (sh, log ε 4.49), 247 (4.71), 293 (3.52), 306 (3.60), 360 nm (4.06); ^1H nmr (deuteriochloroform): δ 5.65 (2H, s, CH_2), 6.7-8.3 (14H, m); ms: m/z (%) 340 (M^+), 235 (M^+-COPh).

Anal. Calcd. for $C_{22}H_{16}N_2O_2$: C, 77.63; H, 4.74; N, 8.23. Found: C, 77.61; H, 4.89; N, 8.24.

Compound **1a** was also recovered in a yield of 140 mg (61%).

1-(4-Methoxyphenacyl)-2-phenylcycloheptimidazol-4(1*H*)-one (**9c**).

This compound was obtained from the reaction with 4-methoxyphenacyl bromide in a yield of 45 mg (12%) as yellow prisms, mp 243-244°; ir (chloroform): ν max 1690 (C=O), 1625 cm^{-1} (C=O); uv (methanol): λ max 226 (log ε 4.69), 246 (4.63), 285 (4.55), 360 nm (4.18); ^1H nmr (deuteriochloroform): δ 3.90 (3H, s, OCH_3), 5.64 (2H, s, CH_2), 6.8-8.3 (13H, m); ms: m/z (%) 370 (M^+, 45).

Anal. Calcd. for $C_{23}H_{18}N_2O_3$: C, 74.58; H, 4.90; N, 7.56. Found: C, 74.72; H, 5.04; N, 7.58.

Compound **1a** was also recovered in a yield of 135 mg (61%).

1-(4-Chlorophenacyl)-2-phenylcycloheptimidazol-4(1*H*)-one (**9d**).

This compound was obtained from the reaction with 4-chlorophenacyl bromide in a yield of 51 mg (14%) as yellow prisms, mp 239-240°; ir (chloroform): ν max 1729 (C=O), 1625 cm^{-1} (C=O); uv (methanol): λ max 230 (sh, log ε 4.55), 254 (4.73), 293 (3.94), 308 (3.91), 360 nm (4.11); ^1H nmr (deuteriochloroform): δ 5.86 (2H, s, CH_2), 6.6-8.2 (13H, m); ms: m/z (%) 374 (M^+, 100).

Anal. Calcd. for $C_{22}H_{15}N_2O_2Cl$: C, 70.49; H, 4.03; N, 7.48. Found: C, 70.62; H, 4.01; N, 7.51.

Compound **1a** was also recovered in a yield of 142 mg (65%).

Reactions of the Compound **1b** with Bromoacetone or Phenacyl Bromides.

General Procedure.

A solution of compound **1b** (157 mg, 1.0 mmole) and bromoacetone (0.1 ml) or phenacyl bromide (1.1 mmoles) in acetonitrile (10 ml) was refluxed for 1 hour. After adding potassium carbonate (290 mg, 2.0 mmoles) and water (10 ml), the mixture was refluxed for 30 minutes. The acetonitrile was evaporated off. The residue was triturated with water, acidified with 30% acetic acid, and washed with chloroform. The aqueous layer was made to basic with 2*M* sodium hydroxide solution and cooled to deposit crystals. The precipitate was collected and recrystallized from ethanol-hexane to give 2-methyl- or 2-aryl-9-aminocyclohept[*d*]-imidazo[1,2-*a*]imidazoles **10a-d**.

9-Amino-2-methylcyclohept[*d*]imidazo[1,2-*a*]imidazole (**10a**).

This compound was obtained from the reaction with bromoacetone in a yield of 156 mg (80%) as orange prisms, mp 254-255° dec; ir (potassium bromide): ν max 3300 cm^{-1} (NH); uv (methanol): λ max 259 (log ε 4.46), 320 (3.97), 337 (3.97), 420 nm (3.83); ^1H nmr (deuteriodimethyl sulfoxide): δ 2.33 (3H, s, CH_3), 6.8-8.0 (4H, m, 3-, 5-, 6-, 7-H), 8.1-8.4 (1H, m, 4-H), 8.1 (2H, br, NH_2); ms: m/z (%) 198 (M^+, 100).

Anal. Calcd. for $C_{11}H_{10}N_4$: C, 66.65; H, 5.09; N, 28.27. Found: C, 66.49; H, 4.92; N, 28.51.

9-Amino-2-phenylcyclohept[*d*]imidazo[1,2-*a*]imidazole (**10b**).

This compound was obtained from the reaction with phenacyl bromide in a yield of 190 mg (73%) as orange prisms, mp 239-241° dec; ir (potassium bromide): ν max 3300 cm^{-1} (NH); uv (methanol): λ max 271 (log ε 4.47), 328 (4.29), 353 (sh, 4.14), 415 (3.79), 441 nm (sh, 3.77); ^1H nmr (deuteriodimethyl sulfoxide): δ 6.9-8.2 (8H, m, 5-, 6-, 7-H, Ph), 8.2-8.6 (1H, m, 4-H), 8.3 (2H, br, NH_2), 8.37 (1H, s, 3-H); ms: m/z (%) 260 (M^+, 100).

Anal. Calcd. for $C_{16}H_{12}N_4$: C, 73.83; H, 4.65; N, 21.53. Found: C, 73.82; H, 4.86; N, 21.26.

9-Amino-2-(4-methoxyphenyl)cyclohept[*d*]imidazo[1,2-*a*]imidazole (**10c**).

This compound was obtained from the reaction with 4-methoxyphenacyl bromide in a yield of 176 mg (62%) as orange prisms, mp 242-244° dec; ir (potassium bromide): ν max 3300 cm^{-1} (NH); uv (methanol): λ max 268 (log ϵ 4.46), 338 (4.30), 350 (sh, 4.26), 415 (3.89), 443 nm (sh, 3.73); ^1H nmr (deuteriodimethyl sulfoxide): δ 3.78 (3H, s, CH_3), 6.8-8.0 (3H, m, 5-, 6-, 7-H), 6.9-7.1 (2H, m), 7.8-8.0 (2H, m), 8.2 (2H, br, NH_2), 8.2-8.5 (1H, m, 4-H), 8.23 (1H, s, 3-H); ms: m/z (%) 290 (M^+, 100), 275 (M^+-CH_3, 37).

Anal. Calcd. for $C_{17}H_{14}N_4O$: C, 70.33; H, 4.86; N, 19.30. Found: C, 70.48; H, 5.02; N, 19.28.

9-Amino-2-(4-chlorophenyl)cyclohept[*d*]imidazo[1,2-*a*]imidazole (**10d**).

This compound was obtained from the reaction with 4-chlorophenacyl bromide in a yield of 214 mg (74%) as orange prisms, mp 275-277° dec; ir (potassium bromide): ν max 3320 cm^{-1} (NH); uv (methanol): λ max 268 (log ϵ 4.60), 330 (4.37), 350 (sh, 4.26), 415 nm (3.93); ^1H nmr (deuteriodimethyl sulfoxide): δ 7.1-8.0 (3H, m, 5-, 6-, 7-H), 7.4-7.6 (2H, m), 7.8-8.1 (2H, m), 8.3-8.6 (1H, m, 4-H), 8.63 (1H, s, 3-H), 8.8 (2H, br, NH_2); ms: m/z (%) 294 (M^+, 100).

Anal. Calcd. for $C_{16}H_{11}N_4Cl$: C, 65.20; H, 3.76; N, 19.01. Found: C, 65.41; H, 3.79; N, 18.93.

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