10, 15, 20, and 30 min. Absorption spectra of them were drawn against the reagent blank which was prepared by substituting glac. AcOH for the cholesterol solution.

Fig. 2 : The same mixture as described above was heated similarly for 20 min., and the color developed was extracted with 5.00 ml. of $CHCl_3$. Both the $CHCl_3$ and acid layer were submitted to the spectral measurements. The spectra were drawn against the corresponding layers prepared similarly from the reagent blank.

Fig. 3 : A solution of 0.406 mg. of 3,3′-bi[cholesta-2.4-diene] in 5.00 ml. of $CHCl_3$ was shaken with the reagent blank, and the orange red $CHCl_3$ layer was submitted to the spectral measurement. The spectrum was drawn against the corresponding $CHCl_3$ layer prepared from the reagent blank.

Fig. 4 : A solution of a small amount of cholesta-3,5-diene in about 1 ml. of $CHCl_3$ was shaken with about 1 ml. of the color reagent. The absorption spectrum of the orange red $CHCl_3$ layer was drawn against the corresponding $CHCl_3$ layer prepared similarly from the color reagent.

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Summary

3,3′-Bi[cholesta-2,4-diene], an oily mixture, cholesta-3,5-diene, cholesteryl chloride, and cholesteryl acetate were isolated from the reaction mixture of cholesterol with perchloric acid, phosphoric acid, and ferric chloride. The first three substances were shown to be responsible for the coloration. Ferric chloride played a considerably important role in the coloration.

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UDC 547.853.07

193. Akira Takamizawa and Kentaro Hirai : Studies on the Pyrimidine Derivatives. XXXII.*1 Syntheses of N-Substituted Pyrimidine and Related Compounds. (1).*2

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In previous papers*1,1) of this series, we have reported about the acid catalyzed condensation reaction of urea, N-methylurea, and N-phenylurea with enol ether ester (ethyl 2-methoxymethylene-3-ethoxypropionate (I)) or enol ether nitrile(2-methoxymethylene-3-ethoxypropionitrile (II)).

In order to extend the scope of this reaction, N-benzylurea and N-allylurea were made to react with I or II.

Reaction of I with N-benzylurea in ethanol solution in the presence of hydrochloric acid afforded a product of m.p. 117~118°, $C_{14}H_{16}O_3N_2$, which showed two spots on a thin-layer chromatogram (TLC).*4 The proton magnetic resonance (NMR)*5 spectrum of the

*1 Part XXXI. A. Takamizawa, K. Hirai : This Bulletin, **12**, 804 (1964).

*2 A part of this paper was presented at the 84th Annual Meeting of the Pharmaceutical Society of Japan, Tokyo, April, 1964.

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*4 TLC : Alumina plate, AcOEt solvent, detected by I_2 vapor.

*5 All NMR spectra were taken with a Varian A-60 spectrometer on about 10% solution in deuteriochloroform containing about 1% tetramethylsilane (TMS) as an internal reference.

1) A. Takamizawa, K. Hirai, Y. Sato, K. Tori : J. Org. Chem., **29**, 1740 (1964).

acetate of this product exhibited the proton signals of two N-acetyl groups whose relative integrated intensities are about 6:1. It can be considered that this acetate was the mixture of ethyl 1-benzyl-2-oxo-3-acetyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (Ⅲ) and the 1-acetyl-3-benzyl isomer Ⅳ in a ratio of about 6:1. This mixture was subjected to column chromatography on alumina and the acetyl group was removed to give two crystalline products, m.p. 143~144° (Ⅴ) and m.p. 116° (Ⅵ), separately. The NMR spectrum of Ⅴ showed a NH proton signal at 4.0 τ which agreeded with the chemical shift for the 3-NH group.*[1,1,2)] Therefore, Ⅴ should be formulated to be ethyl 1-benzyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate. In contrast, the NMR spectrum of Ⅵ showed a doulet (J=5.5 c.p.s.) at 1.18 τ due to the NH group and C_6-methylidyne proton signal as the triplets of doublet (J=5.5, 1.0 c.p.s.) at 2.78 τ, which changed to a triplet by addition of a small amount of deuterium oxide to the solution examined (Table I). Accordingly, the NH group should be situated at a position adjacent to the C_6-methylidyne group,*[1,1,2)] and Ⅵ can be formulated as the 3-benzyl isomer.

Table I. Nuclear Magnetic Resonance Spectral Data of Tetrahydropyrimidines[a,b)]

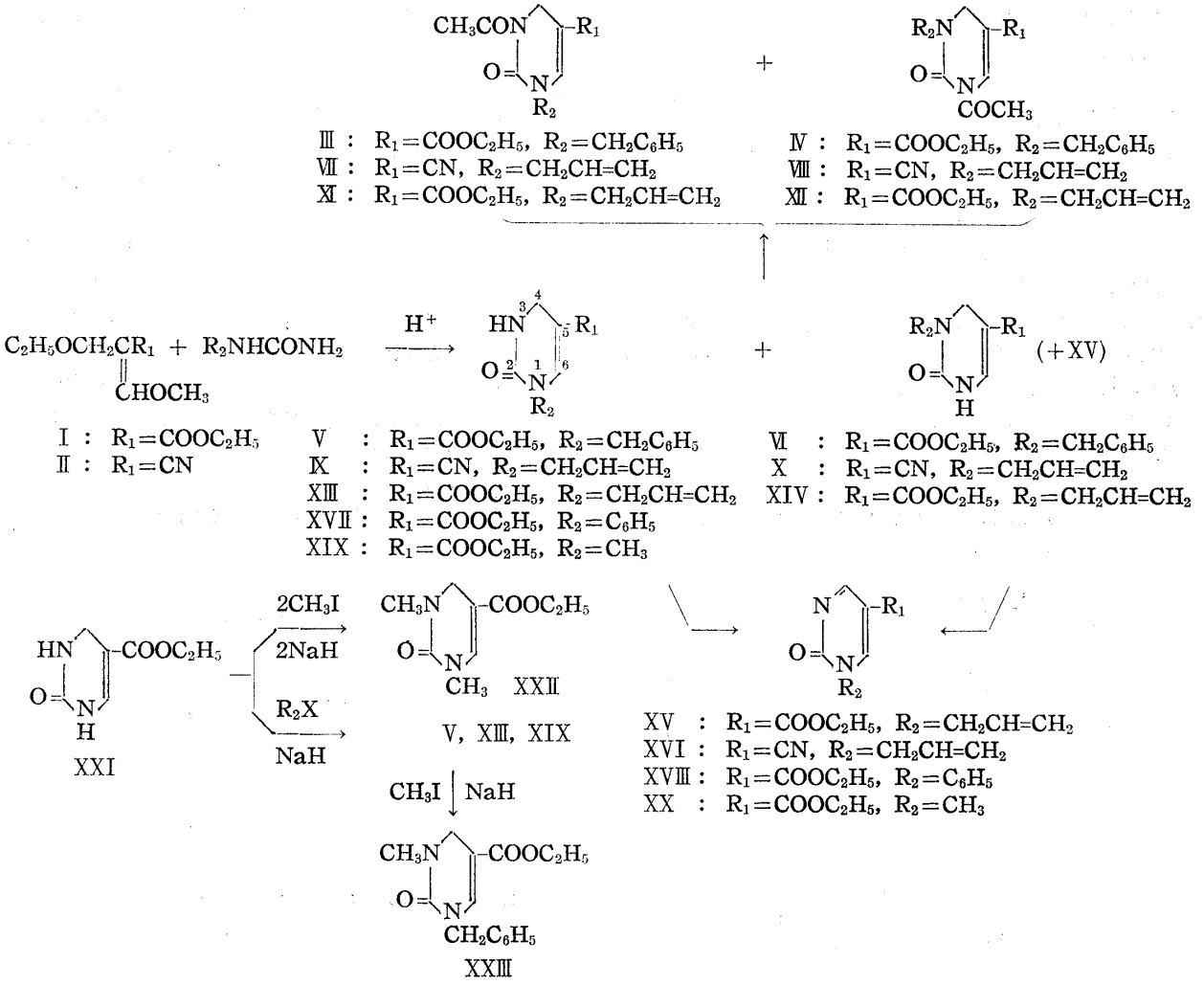
Compound	τ Value	
	NH	C_6-Methylidyne
Ⅴ	4.0 [b]	2.80 [t]
Ⅵ	1.18 [b,d]	2.78 [d−t] (J=5.5, 1.0)
Ⅸ	3.67 [b]	3.22 [t]
Ⅹ	1.12 [b,d]	3.18 [d−t] (J=5.0, 1.0)
ⅩⅢ	3.95 [b]	2.88 [t]
ⅩⅣ	1.37 [b,d]	2.78 [d−t] (J=5.6, 1.0)
ⅩⅩⅢ	—	2.80 [t]

a) Peak multiplicities are presented by b (broad), d (doublet), t (triplet), and d-t (triplets of doublet).
b) $J_{4,6}$=1.0 c.p.s., $J_{3,4}$=1.0 c.p.s.

Similarly, the reaction of N-allylurea with Ⅱ in ethanol solution in the presence of hydrochloric acid was carried out, and a product of m.p. 116~119°, $C_8H_9ON_3$, was obtained. However, the TLC of this product showed two spots, and the NMR spectrum of the acetate of this product revealed that this acetate was the mixture of ethyl 1-allyl-2-oxo-3-acetyl-1,2,3,4-tetrahydro-5-pyrimidinecarbonitrile (Ⅶ) and 1-acetyl-3-allyl isomer (Ⅷ) in a ratio of about 2:1. The condensation products were isolated by alumina column chromatography and two crystalline products, m.p. 131° (Ⅸ) and m.p. 94° (Ⅹ), were obtained separately. The NMR spectrum of Ⅸ exhibited the NH proton signal at 3.67 τ which indicated that NH group should be situated at 3-position, and that of Ⅹ exhibited a doublet (J=5.0 c.p.s.) at 1.12 τ due to the NH group and C_6-methylidyne proton signal at 3.18 τ as the triplets of doublet (J=5.0, 1.0 c.p.s.), which was decoupled to a triplet by the proton exchanging of NH group (Table I). Thus, the structures of Ⅸ and Ⅹ were assigned to be 1-allyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarbonitrile and 3-allyl isomer, respectively.

Moreover, the reaction of Ⅰ and N-allylurea in ethanol solution in the presence of hydrochloric acid was carried out, and a product of m.p. 98~101°, $C_{10}H_{14}O_3N_2$, was obtained in good yield. This product also showed two spots on TLC, and the NMR spectrum of the acetate of this product indicated that this acetate was a mixture of ethyl 1-allyl-2-oxo-3-acetyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (Ⅺ) and 1-acetyl-3-allyl isomer (Ⅻ) in a ratio of about 3:1. The condensation products were isolated by alumina

2) K. Tori, K. Aono, K. Hirai, A. Takamizawa : Ann. Rept. Shionogi Res. Lab., **14**, 198 (1964).



column, and each isomer, m.p. 126° (XIII) and m.p. 103° (XIV), was obtained separately. The NMR spectrum of XIII showed a 3-NH proton signal at 3.95 τ, and that of XIV showed a doublet (J=5.6 c.p.s.) at 1.37 τ due to the 1-NH group and the triplets of doublet (J=5.6, 1.0 c.p.s.) at 2.78 τ due to C_6-methylidyne proton, which was decoupled by the proton exchanging of the NH group (Table I). Thus, the structures of XIII and XIV were assigned as ethyl 1-allyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate and 3-allyl isomer, respectively.

In these reactions, there was the fear that the 1-substituted compound or 3-substituted isomer may be produced exclusively, then isomerized to give the equilibrium of two isomers. So, XIII and XIV were heated under the same condition separately, but isomerization was not observed and the original XIII and XIV were recovered, respectively. From these results, the possibility of interconversion between each isomers was excluded.

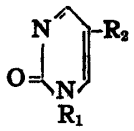
In the course of the isolation procedure on column chromatography, the crystalline product, m.p. 118° (XV), was also isolated. By elemental analysis, XV was shown to have 1 mole of hydrogen less than XIII or XIV. Therefore, it was considered that XV should be a dehydrogenated product. Infrared spectrum of XV exhibited CH deformation and a stretching band for the allyl group at 990 and 920 cm^{-1}, but no NH band. These results suggest that dehydrogenation had occurred between 3-, and 4-position in tetrahydropyrimidine compound. The NMR spectrum of XV supports this suggestion by showing the two doublets (J=3 c.p.s.) at 0.95 and 1.60 τ due to the protons at 4-, and 6-positions in

Table IIa. Nuclear Magnetic Resonance and Ultraviolet Spectral Data of Dihydropyrimidines

Compound	τ Value		λ_{max}^{EtOH} mμ (log ε)		
	C_4-H[a]	C_6-H[a]			
XV	0.95	1.60	247 (4.16)	272 (3.79)	310[b] (3.47)
XVI	1.28	1.83	264 (4.11)	315 (2.53)	
XVIII	0.88	1.58	252.5 (4.05)	273 (4.02)	315[b] (3.29)
XX	0.97	1.47	246 (4.25)	274[b] (3.67)	306 (3.52)

a) Doublet (J=3.3 c.p.s)
b) Approximate inflection points

Table IIb. Dihydropyrimidines



Compound	R_1	R_2	m.p. (°C)	Yield (%)	Appearance
XV	$CH_2CH=CH_2$	$COOC_2H_5$	117~118[a]	92.3 (from XIII) 69.2 (from XIV)	colorless rhombics
XVI	$CH_2CH=CH_2$	CN	147~148[b]	58.6	colorless needles
XVIII	C_6H_5	$COOC_2H_5$	103~104[c]	73.5	colorless prisms
XX	CH_3	$COOC_2H_5$	170[b]	80.2	colorless pillars

Recryst. from a) AcOEt-Et_2O, b) AcOEt, c) AcOEt-petr. ether.

Table IIc. Analytical Data of the Compounds shown in Table IIb

Compound	Formula	Calcd. (%)			Found (%)		
		C	H	N	C	H	N
XV	$C_{10}H_{12}O_3N_2$	57.68	5.81	13.46	57.39	5.89	13.12
XVI	$C_6H_7ON_3$	59.62	4.38	26.07	59.68	4.58	25.64
XVIII	$C_{13}H_{12}O_2N_2$	63.92	4.95	11.47	64.05	5.11	11.59
XX	$C_8H_{10}O_3N_2$	52.74	5.53	15.38	52.81	5.61	15.33

pyrimidine (Table IIa). The structure of XV was assigned as ethyl 1-allyl-2-oxo-1,2-dihydro-5-pyrimidinecarboxylate. It can be considered that the dehydrogenation of XIII or XIV has occurred during the alumina chromatography to give XV.

In order to confirm this dehydrogenation, the mixture of XIII and XIV was made to react with 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) in dioxane solution,[1] and XV was obtained in good yield. The dehydrogenation of XIII and XIV was made separately to yield the same product (XV).

Similarly, IX and X were dehydrogenated by the action of DDQ in dioxane solution to give 1-allyl-2-oxo-1,2-dihydro-5-pyrimidinecarbonitrile (XVI). Ethyl 1-phenyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XVII)*1 was also converted to the 1,2-dihydro derivative (XVIII).

It was found that ethyl 1-methyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XIX)[1] was readily dehydrogenated by various dehydrogenating reagents, such as DDQ, chloranil, or bromine, to give the 1,2-dihydro derivative (XX). In the case of action of bromine on XIX in acetic acid solution, XX was obtained as hydrobromide.

Attempts were made to substitute the NH groups of ethyl 2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XXI)[1] by various substituents. Action of two moles of sodium

hydride on XXI with subsequent reaction of excess methyl iodide in absolute dioxane solution gave ethyl 2-oxo-1,3-dimethyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XXII). On the other hand, when 1 mole of sodium hydride and methyl iodide, allyl bromide, or benzyl bromide were used, the respective monosubstituted compounds were obtained in good yield as a sole product.

It was confirmed that the substitution occurred at the 1-position of XXI by the fact that the respective monosubstituted compounds showed the identical infrared spectra with those of XIX, XIII, and V, respectively. When V reacted with methyl iodide in the presence of sodium hydride, ethyl 1-benzyl-2-oxo-3-methyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XXIII) was obtained. These results indicate that the 1-NH group in XXI was preferentially alkylated because of higher acidity of the 1-NH group as compared to the 3-NH group.

N-Substituted tetrahydropyrimidines obtained above were easily dehydrogenated to give the respective N-substituted dihydropyrimidines. Therefore, it should be noted that these syntheses are convenient in obtaining N-substituted pyrimidine derivatives.

Experimental*6

Ethyl 1-Benzyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (V) and Ethyl 2-Oxo-3-benzyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (VI)——A solution of 1.9 g. of I, 1.5 g. of N-benzylurea, and 2.0 ml. of conc. HCl in 100 ml. of EtOH was refluxed for 11 hr. The solution was concentrated *in vacuo*, neutralized with $NaHCO_3$ solution, and extracted with $CHCl_3$. The $CHCl_3$ extract, after drying over anhyd. $MgSO_4$, was evaporated to give the product which on recrystallization from EtOH gave 2.1 g. (80.7%) of colorless prisms, m.p. 117~118°. TLC: Rf 0.56, 0.48. *Anal.* Calcd. for $C_{14}H_{16}O_3N_2$: C, 64.60; H, 6.20; N, 10.76. Found: C, 64.64; H, 6.35; N, 11.00.

A mixture of 2.0 g. of the product obtained above and 15 ml. of Ac_2O was refluxed for 3 hr. The reaction mixture was concentrated *in vacuo* to give 2.3 g. of pale yellow oil. NMR spectrum of this crude acetate showed two N-acetyl protons' signals at 7.47 and 7.33 τ, whose relative integrated intensities are about 6:1.

This mixture of crude acetates was chromatographed on alumina. The $CHCl_3$ elutions which showed one spot on TLC at Rf 0.56 were collected and $CHCl_3$ was removed to give 1.43 g. of prisms. Recrystallization from EtOH gave colorless prisms of m.p. 143~144°. NMR spectrum (Table I) shows that these crystals are V. UV λ_{max}^{EtOH} mμ (log ε): 208 (3.89), 297 (4.01). *Anal.* Found: C, 64.61; H, 6.06; N, 10.69.

The fractions which showed one spot on TLC at Rf 0.48 were collected and $CHCl_3$ was removed to give 0.24 g. of prisms which were recrystallized from petr. ether-benzene to colorless prisms, m.p. 116°. NMR spectrum (Table I) shows that these crystals are VI. UV λ_{max}^{EtOH} mμ (log ε): 208 (4.14), 290 (4.18). *Anal.* Found: C, 64.60; H, 6.28; N, 10.71.

1-Allyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarbonitrile (IX) and 2-Oxo-3-allyl-1,2,3,4-tetrahydro-5-pyrimidinecarbonitrile (X)——A solution of 2.82 g. of II, 2.00 g. of N-allylurea, and 2.5 ml. of conc. HCl in 200 ml. of EtOH was refluxed for 27 hr. The solution was treated as above to yield 1.32 g. (40.4 %) of colorless prisms, m.p. 116~119°. TLC: Rf 0.51, 0.40. *Anal.* Calcd. for $C_8H_9ON_3$: C, 58.88; H, 5.56; N, 25.75. Found: C, 58.90; H, 5.66; N, 25.99. A mixture of 0.05 g. of the product obtained above and 1.0 ml. of Ac_2O was refluxed for 1 hr. The reaction mixture was concentrated *in vacuo* to give the oily residue. NMR spectrum of this crude acetate showed two N-acetyl protons' signals at 7.45 and 7.37 τ, whose relative integrated intensities are about 2:1.

The crystalline products, m.p. 116~119° (1.3 g.), were chromatographed on alumina. The $CHCl_3$ elution which showed one spot on TLC at Rf 0.56 were collected and the solvent was removed to give 0.93 g. of crystals. Recrystallization from EtOH gave 0.85 g. of colorless needles, m.p. 130~131°. NMR spectrum (Table I) showed that these crystals are IX. UV λ_{max}^{EtOH} mμ (log ε): 213 (3.92), 285 (4.03). *Anal.* Found: C, 59.07; H, 5.85; N, 25.41.

The fractions which showed one spot on TLC at Rf 0.40 were collected and the $CHCl_3$ was removed to leave 0.11 g. of crystals. Recrystallization from benzene-petr. ether afforded 0.08 g. of colorless needles, m.p. 94°. NMR spectrum (Table I) showed that these crystals are X. UV λ_{max}^{EtOH} mμ (log ε): 217.5 (3.94), 280 (4.16). *Anal.* Found: C, 58.89; H, 5.96; N, 25.54.

Ethyl 1-Allyl-2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XIII) and Ethyl 2-Oxo-3-allyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XIV)——A solution of 1.9 g. of I, 1.2 g. of N-allylurea, and 2.0

*6 All melting points were taken on a Köfler hot plate and are uncorrected.

ml. of conc. HCl in 100 ml. of EtOH was refluxed for 13 hr. The solution was treated as above to afford 1.9 g. (90.2%) of crystals, which were recrystallized from benzene-petr. ether to give colorless needles, m.p. 98~101°. TLC: Rf, 0.50, 0.40. *Anal.* Calcd. for $C_{10}H_{14}O_3N_2$: C, 57.13; H, 6.71; N, 13.33. Found: C, 56.99; H, 6.98; N, 13.28.

A mixture of 0.1 g. of the product obtained above and 2.0 ml. of Ac_2O was refluxed for 3 hr. The reaction mixture was concentrated *in vacuo* to leave a pale brown solid. NMR spectrum of this crude acetate showed two N-acetyl protons' signals at 7.46 and 7.35 τ, whose relative integrated intensities are about 3:1.

The crystalline product, m.p. 98~101° (2.4 g.), was chromatographed on alumina. The $CHCl_3$ elutions which showed one spot on TLC at Rf 0.50 were collected and the solvent was removed to leave the crystals which were recrystallized from benzene to give 1.8 g. of colorless prisms, m.p. 126°. NMR spectrum (Table I) showed that these crystals are XIII. UV λ_{max}^{EtOH} mμ (log ε): 215 (3.94), 297 (4.01). *Anal.* Found: C, 57.44; H, 6.86; N, 13.43.

The fractions which showed one spot on TLC at Rf 0.40 were collected and the $CHCl_3$ was removed to give 0.5 g. of colorless needles, m.p. 103°. NMR (Table I) showed that these crystals are XIV. UV λ_{max}^{EtOH} mμ (log ε): 220 (3.93), 290 (3.95). *Anal.* Found: C, 57.02; H, 6.76; N, 13.46.

Investigation for Isomerization——The solution of 150 mg. of XIII and 0.3 ml. of conc. HCl in 15 ml. of EtOH was refluxed for 7 hr. The solution was checked by TLC each 1 hr. and the change of the spot at Rf 0.50 was not observed. After 7 hr., the solution was concentrated *in vacuo* to recover the original XIII.

The same procedure was carried out on XIV and no change was seen to recover XIV.

Ethyl 1-Allyl-2-oxo-1,2-dihydro-5-pyrimidinecarboxylate (XV)——a) The $CHCl_3$ elutions which showed one spot on TLC at Rf 0.54 during the alumina chromatography of above products (XIII, XIV) were collected and the solvent was removed to give the crystals. Recrystallization from AcOEt-Et_2O gave 0.15 g. of colorless rhombics, m.p. 115~118°. UV λ_{max}^{EtOH} mμ (log ε): 247 (4.16), 272 (3.79), 310 (3.47).

b) The mixture of XIII and XIV, m.p. 98~101° (268 mg.), was dissolved in 5.0 ml. of abs. dioxane. To this solution, the solution of 298 mg. of DDQ in 6.0 ml. of abs. dioxane was added and heated at 95° for 1 hr. After cooling, the separated 2,3-dichloro-5,6-dicyanohydroquinone was filtered off and the filtrate was concentrated *in vacuo* to leave the crystals. Recrystallization from AcOEt gave 125 mg. of colorless prisms, m.p. 117~118°. IR spectrum of these crystals was identical with the sample obtained above a).

General Procedure for the Action of DDQ on N-Substituted Tetrahydropyrimidines——To the solution of 0.001 mole of N-substituted tetrahydropyrimidine in 2.0 ml. of abs. dioxane, the solution of 0.001 mole of DDQ in 4.0 ml. of abs. dioxane was added and heated at 90° for 1 hr. After cooling, the separated 2,3-dichloro-5,6-dicyanohydroquinone was filtered off and the filtrate was concentrated *in vacuo*. The residue was recrystallized from the suitable solvents to give the products as shown in Table IIb.

Ethyl 1-Methyl-2-oxo-1,2-dihydro-5-pyrimidinecarboxylate (XX)——a) XX was obtained by the procedure described above in 80.2% yield.

b) To a solution of 184 mg. of XIX in 3.0 ml. of abs. dioxane, the solution of 246 mg. of chloranil in 2.0 ml. of abs. dioxane was added and refluxed for 1 hr. Reaction mixture was concentrated *in vacuo* and the residue was purified with Al_2O_3 chromatography followed by recrystallization from AcOEt to give 90 mg. (49.7%) of colorless pilars. IR spectrum showed the identity with the sample obtained above a).

c) To a solution of 184 mg. of XIX in 1.0 ml. of glacial AcOH, the solution of 200 mg. of bromine in 1.0 ml. of glacial AcOH was added and refluxed for 1 hr. The reaction mixture was concentrated *in vacuo* to give the residue, which was recrystallized from EtOH-AcOEt to give 200 mg. (76%) of colorless prisms, m.p. 187~189° (decomp.). *Anal.* Calcd. for $C_8H_{10}O_3N_2 \cdot HBr$: C, 36.52; H, 4.22; N, 10.65; Br, 30.39. Found: C, 36.12; H, 4.40; N, 10.62; Br, 30.73

General Procedure for the Syntheses of N-Substituted Tetrahydropyrimidines (V, XIII, XIX)——To a solution of 0.004 mol. of XXI in 5 ml. of abs. dioxane, 0.004 mol. of NaH (50% oil) was added. To this solution, 0.0044 mol. of $C_6H_5CH_2Br$, $CH_2{=}CHCH_2Br$, and CH_3I was added respectively and refluxed for 1.5 hr. in an oil bath. TLC of the reaction mixture showed a sole product was produced. The reaction mixture was filtered and the filtrate was concentrated *in vacuo*. The residue was recrystallized from AcOEt to give V, m.p. 141°; XIII, m.p. 124~125°; XIX, m.p. 127°, respectively. Yield: V, 88.7%; XIII, 63.3%; XIX, 72.4%. The identity with the sample prepared previously was confirmed by the comparison of IR spectra and the mixed melting point.

Ethyl 2-Oxo-1,3-dimethyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XXII)[1]——To a solution of 340 mg. of XXI in 5.0 ml. of abs. dioxane, 192 mg. of NaH (50% oil) and 1.0 ml. of CH_3I was added and refluxed for 1 hr. After filtration, the filtrate was concentrated *in vacuo* to give the crystalline residue, which was washed with petr. ether to give 351 mg. (88.7%) of the crystals. Recrystallization from Et_2O-petr. ether gave 209 mg. of colorless prisms, m.p. 91~93°, identical with the sample obtained previously by other method.[1]

Ethyl 1-Benzyl-2-oxo-3-methyl-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XXIII)——To a solution of 68 mg. of V in 1.0 ml. of abs. dioxane, 12 mg. of NaH (50% oil) and 0.2 ml. of CH_3I was added and refluxed for 1 hr. After filtration, the filtrate was concentrated *in vacuo* and the residue was treated with petr. ether to give 57 mg. (79.6%) of the crystals, which was recrystallized from AcOEt-petr. ether to give colorless prisms, m.p. 100~101°. TLC 0.64. IR: nil ν_{NH}. NMR: 7.03 ($-NCH_3$), 5.90 d ($-CH_2-$), 5.30 ($-NCH_2-$), 2.80 t (=CH), 2.72 τ (C_6H_5). *Anal.* Calcd. for $C_{15}H_{18}O_3N_2$: C, 65.67; H, 6.61; N, 10.21. Found: C, 65.12; H, 6.69; N, 10.32.

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Summary

The acid catalyzed condensation reactions of N-substituted ureas with enolether ester (I) or nitrile (II) were carried out, and the condensation products were isolated and those structures were confirmed. Alkylation of ethyl 2-oxo-1,2,3,4-tetrahydro-5-pyrimidinecarboxylate (XXI) afforded N-substituted tetrahydropyrimidines. Dehydrogenation of these N-substituted tetrahydropyrimidines gave N-substituted dihydropyrimidines readily.

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194. Yasuo Makisumi: The Claisen Rearrangement in Aromatic Heterocyclic Compounds. II.*1 The Thermal Rearrangement of Allyl 4-Quinolyl Ethers.

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In the preceding paper,*1 it was reported that the thermal rearrangement of allyl 2-methyl-4-quinolyl ethers affords the *ortho*-Claisen rearrangement products in about 90% yields along with their consecutive intramolecular cyclization products, the 2,3-dihydrofuro[3,2-*c*]quinoline derivatives. This reaction is unique in that rearrangement of an allyl group to an *ortho*-carbon atom takes place when the possibility for rearrangement[1] to a ring nitrogen atom also exists. It was of interest to determine whether rearrangement of allyl 4-quinolyl ethers would give a mixture of rearrangement products to the *ortho*-carbon and *para*-nitrogen atoms such as had been obtained from 5-methyl-7-allyloxy-*s*-triazolo[1,5-*a*]pyrimidine,[2] or whether exclusive rearrangement to the *ortho*-carbon atom would occur such as in the preceding work on allyl 2-methyl-4-quinolyl ethers.

For this purpose, allyl, methallyl, and crotyl ethers (Ia, Ib, and Ic) of 4-quinolinol were prepared by treatment of 4-chloroquinoline with sodium allyloxide, methallyloxide,

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*1 Part I. Y. Makisumi: This Bulletin, **12**, 789 (1964).

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1) M. Conrad, L. Limpach: Ber., **20**, 948 (1887); M. Conrad, Fr. Eckhardt: *Ibid.*, **22**, 73 (1889); H. Meyer: Monatsh., **27**, 259, 265 (1906).

2) Y. Makisumi: This Bulletin, **11**, 851 (1963).