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Convenient Syntheses of 1, 2-Ureylenecyclopentane Derivatives*[1]

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Three Convenient syntheses of *cis*-1, 2-ureylenecyclopentane (VI) and *cis-cis*-3-methyl-1, 2-ureylenecyclopentane (VIa), from 2-carbethoxycyclopentanone (I) and 5-methyl-2-carbethoxycyclopentanone (Ia) respectively, are described. The Curtius degradation of *cis*-2-aminocyclopentanecarboxylic acid derivatives took place without *cis-trans* isomerization. The hydrogenation of ethyl 3-methyl-2-ureidocyclopent-1-ene-1-carboxylate at 70°C gave two isomeric products, the major (IIIa), *cis-cis*-, and the minor (IIIb), *cis-trans*-3-methyl-2-ureido-1-carbethoxycyclopentane.

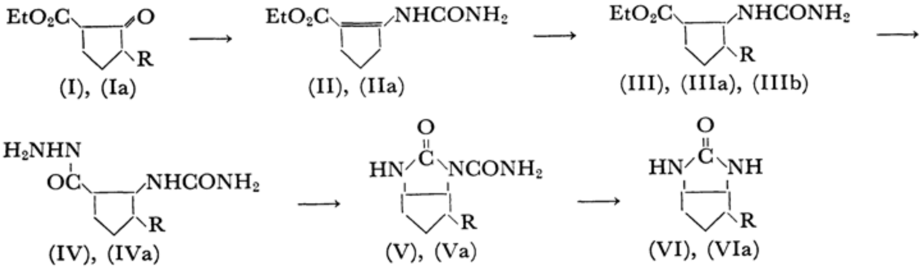
In connection with our studies of the improved total synthesis of *dl*-biotin, we have now synthesized 3-substituted *cis*-1, 2-ureylenecyclopentane (VI), which appears to serve as a model compound of *dl*-biotin. Müller *et al.*[1)] have reported that 1, 2-ureylenecyclopentane (VI) is obtained in a poor yield by the Curtius or Schmidt degradation of *cis*-cyclopentane-1, 2-dicarboxylic acid (XV) derivatives, but the isomerization of the *cis* to the *trans* isomer occurs during the treatment of the derivative with hydrazine or hydrazoic acid.

On the other hand, we have found that the treatment of the cyclopentane-*cis*-β-amino acid derivatives (III and IX) with hydrazine gives the corresponding *cis*-hydrazides without such a rearrangement.

This paper will describe the preparation of cyclopentane-*cis*-β-amino acid derivatives (III and IX) and the conversion of the hydrazides to ureylene compounds by means of the Curtius degradation.

The first route (Method A) to *cis*-1, 2-ureylenecyclopentane (VI) is outlined in Chart 1. 2-Carbethoxycyclopentanone (I) was first converted to 2-ureido-1-carbethoxycyclopent-1-ene (II) by the condensation of I with urea. This condensation was created either by evacuating a mixture of I, urea, absolute ethanol, and a catalytic amount of concentrated hydrochloric acid placed in a desiccator over concentrated sulfuric acid, or by refluxing a mixture of I and urea in an ethanol-benzene solution in the presence of *p*-toluenesulfonic acid. The latter method was found to be superior to the former because of the shortness of its reaction time and the better yield of the product. The catalytic hydrogenation of II over Raney nickel gave *cis*-2-carbethoxyureidocyclopentane (III) in a quantitative yield. III was converted into hydrazide (IV), which gave, by treatment with nitrous acid, a ring-closed compound V in a good yield. The hydrolysis of V afforded 1, 2-ureylenecyclopentane (VI), and the decarbamoylation of V with nitrous acid gave VI, along with a nitroso compound as a by-product. This nitroso compound was also obtained by treating VI with nitrous acid.

The second route (method B) to VI is shown in Chart 2. I is first condensed with ammonia in the presence of ammonium nitrate to form 2-amino-1-carbethoxycyclopent-1-ene (VII)[2)].



I, II, ···, VI: R=H
Ia, IIa, ···, VIa: R=CH_3

Chart 1

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*[1] Studies on the Syntheses of Heterocyclic Compounds. II. Presented at the 19th Annual Meeting of the Chemical Society of Japan, Tokyo, April, 1966. *Cf.* Abstracts, III, p. 442.

1) J. H. Müller, M. N. Donin, W. E. Behnke and K. Hofmann, *J. Am. Chem. Soc.*, **73**, 2487 (1951).

2) V. Prelog and S. Szpilfogel, *Helv. Chim. Acta*, **28**, 1684 (1946).

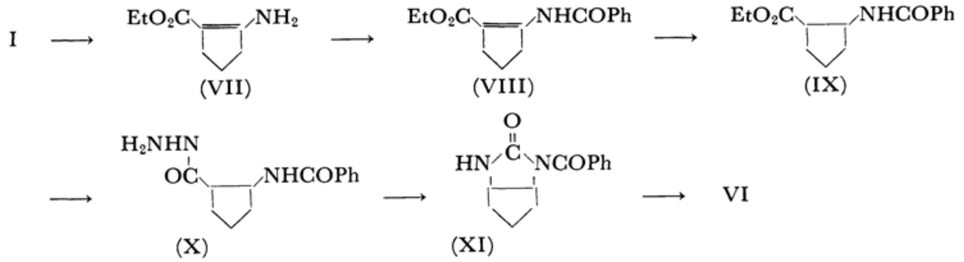
Chart 2

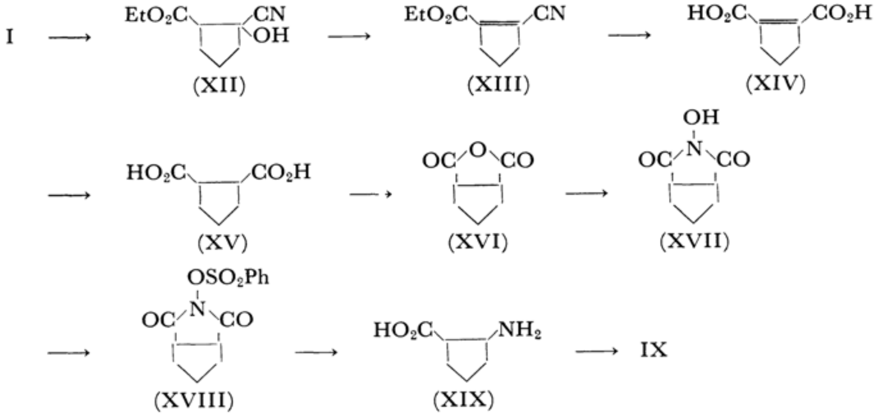
Chart 3

Müller *et al.*[1] have reported that the acetylation of the amino ester (VII), followed by hydrogenation, hydrolysis, benzoylation, esterification, and treatment with hydrazine afforded a *cis-trans* mixture of the hydrazide (X). The melting point of the *trans* isomer was 204—206°C, and that of the *cis-trans* mixture was 171—172°C. However, we obtained only *cis*-hydrazide (X).

The amino ester was benzoylated with difficulty. The benzoylated compound (VIII) was catalytically hydrogenated over Raney nickel to give the *cis*-β-amino acid derivative (IX), which was then converted with hydrazine into *cis*-hydrazide (X). This hydrazine, X, was converted to *N*-benzoyl-1, 2-ureylenecyclopentane (XI) *via* the azide. XI was hydrolyzed with barium hydroxide to VI.

In the third route (method C), VI was synthesized *via* the *cis*-amino acid (XIX), as is outlined in Chart 3. In this method cyclopent-1-ene-1, 2-dicarboxylic acid (XIV) was first prepared in a 70% yield from I through XII and XIII. The unsaturated diacid (XIV) was reduced to *cis*-diacid (XV) by catalytic hydrogenation. The conversion of XV to *cis*-anhydride (XVI) was carried out by refluxing it with acetic anhydride. The treatment of this anhydride (XVI) with hydroxylamine afforded *N*-hydroxycyclopentane-1, 2-dicarboimide (XVII). XVII was converted quantitatively to XVIII by the usual method. XVIII was readily rearranged (Lossen rearrangement[3]) to *cis*-amino acid (XIX) with a base. This amino acid (XIX) was converted to IX by esterification, followed by benzoylation

In order to investigate whether or not the 3-substituted ureylenecyclopentane (VI) obtained from 3-substituted cyclopentane derivatives by the application of the procedure described above has a *cis-cis* configuration, we attempted the synthesis of 3-methyl-1, 2-ureylenecyclopentane (VIa) by the method A. 2-Carbethoxy-5-methylcyclopentanone (Ia) was prepared from diethyl 2-methyladipate[4] by Dieckmann cyclization. The transformation of Ia to IIa was carried out with difficulty. The catalytic hydrogenation of IIa over Raney nickel afforded two isomeric substances, IIIb (mp 100—102°C), and IIIa (mp 146—148°C). IIIb was much more soluble in carbon tetrachloride than IIIa, which was the main product. When the hydrogenation of IIa was carried out at room temperature, the sole product isolated was IIIa; IIIb was not observed. From the NMR data of IIIa, IIIb, and III, we may decide that the lower-melting product, IIIb, has a *cis-trans*[*2] configuration, and that the main product, IIIa, has a *cis-cis* configuration see below. IIIa was converted into

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3) L. Bauer and S. V. Miarka, *J. Org. Chem.*, **24**, 1293 (1959).

4) R. Cornubert and C. Borrel, *Bull. Soc. Chim. France*, [4], **47**, 301 (1930).

[*2] In this designation the relationship between carbethoxy and ureido group is given first, and that between ureido and methyl groups, second.

TABLE 1. NMR SPECTRA AT 60 Mcps OF 10% SOLUTION OF ETHYL *cis*-2-UREIDOCYCLOPENTANECARBOXYLATE (III), ETHYL *cis-cis*-3-METHYL-2-UREIDOCYCLOPENTANECARBOXYLATE (IIIa) AND ETHYL-*cis-trans*-3-METHYL-2-UREIDOCYCLOPENTANECARBOXYLATE (IIIb), RESPECTIVELY, IN CHLOROFORM-d USING TMS REFERENCE AT 24°C

Chemical shift τ (ppm)

Assignment		III	IIIa	IIIb
$-N\underline{H}-$	D*	3.89 (J=9.0 cps)	4.09 (J=9.6 cps)	3.91 (J=7.2 cps)
$-N\underline{H}_2$	S	4.85	4.85	4.83
$-C\underline{H}-NH-$	M	5.32—5.43	5.31—5.60	5.30—5.58
$CH_3C\underline{H}_2-O-$	Q	5.82 (J=7.2 cps)	5.83 (J=7.2 cps)	5.84 (J=6.9 cps)
$-C\underline{H}-CO_2-$	M	6.80—7.15	6.70—7.14	6.75—7.10
$-C\underline{H}_2C\underline{H}_2C\underline{H}_2-$	M	7.80—8.50	7.70—8.50	7.50—8.50
$C\underline{H}_3CH_2-O-$	T	8.72 (J=7.2 cps)	8.75 (J=7.2 cps)	8.74 (J=6.9 cps)
$-CH-C\underline{H}_3$	D		9.01 (J=6.6 cps)	8.97 (J=6.0 cps)
$-C\underline{H}-CH_3$	M		7.80—8.50	7.50—8.50

*D: doublet S: singlet M: multiplet
Q: quartet T: triplet

Va according to the procedure described above. Upon refluxing in a barium hydroxide solution, Va was hydrolyzed to VIa. The yield of the *cis*-1, 2-ureylenecyclopentane (VI) obtained from I were 40, 23, and 15% for Methods A, B, and C respectively. Therefore, Method A was applied to the synthesis of *cis-cis*-3-methyl-1, 2-ureylenecyclopentane (VIa).

However, the yield of VIa from Ia was poorer (9%) than that of VI from I, because of the difficulty of the following three steps, (Ia to IIa), (IVa to Va) and (Va to VIa).

Stereochemistry of the Reaction. *cis*-2-Benzamidocyclopentanecarboxylic acid hydrazide (X) formed a ring compound *N*-benzoyl-1, 2-ureylenecyclopentane (XI), upon treatment with nitrous acid, whereas the trans isomer did not.1) The ring closure of both β-amino acid derivatives, IV and X, was accomplished. Therefore, we concluded that these amino acid derivatives have the *cis*-configuration.

The reduction of IIa with a Raney nickel catalyst gave two products, IIIa and IIIb, in a ratio of about 4 : 1. The elementary analyses of these products supported the idea that they were isomers. The configuration of these isomers may be determined by NMR spectrum measurements. The NMR data of III, IIIa, and IIIb are given in Table 1.

It is difficult to recognize the differences between coupling constants of $H_{2,3}$ in III, IIIa and IIIb. The relative configuration of the methyl group to the ureido group cannot be decided from the coupling constants. The proton of C–NH–CO in IIIa shifts to a higher field as compared with those of IIIb and III. The relationship of the –NH– proton to the proton at the 3-position in IIIb seems to be similar to that in III, but the relationship in IIIa seems to be different from that in III or IIIb. (The inductive effect of the methyl group on the proton of –NH– is negligible). Therefore, the chemical shift of the –NH–CO– proton in IIIa may be different from that of III and IIIb. It may be concluded that methyl and ureido groups have a *cis*-configuration to each other in IIIa. This conclusion may also be supported by the fact that the hydrogenation of IIa gave IIIa as the main product. The relationships between carbethoxy and ureido groups in III, IIIa, and IIIb seem to be *cis*, since both IV and IVa form a ureylene ring and since the catalytic hydrogenation of a double bond shows the *cis* addition of hydrogens in general.

Experimental

All melting points are uncorrected.

2-Ureido-1-carbethoxycyclopentane (II). A) A mixture of finely-ground urea (2.0 g), 2-carbethoxycyclopentanone (I) (4.7 g), absolute ethanol (1 m*l*), and three drops of concentrated hydrochloric acid, placed in an evaporating dish covered loosely with a watch glass, was evacuated continuously by a water pump in a desiccator over concentrated sulfuric acid. After about a week, the mixture, which dried up, was recrystallized from 95% ethanol to give 3.5 g of pure 2-ureido-1-carbethoxycyclopentene (II); mp 197—198°C.

Found: C, 54.64; H, 7.37; N, 14.42%. Calcd for $C_9H_{14}O_3N_2$: C, 54.53; H, 7.12; N, 14.13%.

B) A mixture of II (1.56 g), urea (0.7 g), absolute ethanol (80 m*l*), and *p*-toluenesulfonic acid (0.1 g) was refluxed for 50 hr in a Soxhlet apparatus containing anhydrous sodium sulfate in the thimble. The mixture was concentrated to a small volume, and the residue was recrystallized from 95% ethanol; mp 197—198°C. Yield, 1.62 g (82%).

Ethyl *cis*-2-Ureidocyclopentanecarboxylate (III). II (0.4 g) was hydrogenated in absolute ethanol over Raney nickel under a hydrogen pressure of 70 atm at 70°C for 3 hr. After the catalyst had been separated by filtration, the solvent was concentrated to dryness. A white solid, 0.4 g, was recrystallized from chloroform - carbon tetrachloride; mp 137—138°C.

Found: C, 53.76; H, 8.27; N, 14.04%. Calcd for $C_9H_{16}O_3N_2$: C, 53.98; H, 8.06; N, 13.99%.

***cis*-2-Ureidocyclopentanecarboxylic Acid Hydrazide (IV).** III (1.0 g) was refluxed with 100% hydrazine hydrate (1.5 m*l*) in absolute ethanol (10 m*l*) for 3 hr. The removal of the solvent and excess hydrazine under reduced pressure gave the hydrazide in a quantitative yield; mp 172—173°C (from ethanol-benzene). IV was also obtained by heating III (0.3 g) with hydrazine hydrate (0.4 m*l*) on a steam bath for half an hour.

Found: C, 45.21; H, 7.52; N, 29.92%. Calcd for $C_7H_{14}O_2N_4$: C, 45.15; H, 7.58; N, 30.09%.

***N*-Carbamoyl - 1, 2 - ureylenecyclopentane (V).** Into an ice-cooled solution of IV (310 mg), sodium nitrite (155 mg) in water (3 m*l*) was stirred, drop by drop. After further stirring for ten minutes, the azide was extracted with ice-cold ethyl acetate and the extracts were dried over anhydrous sodium sulfate. The ethyl acetate solution was then refluxed for 3 hr on a steam bath to decompose the azide. The solvent was removed to give 250 mg (89%) of a crude product which was in turn recrystallized from ethyl acetate; mp 162—163°C.

Found: C, 49.85; H, 6.31; N, 24.54%. Calcd for $C_7H_{11}O_2N_3$: C, 49.69; H, 6.55; N, 24.84%.

1, 2-Ureylenecyclopentane (VI). A) A mixture of V (350 mg) and barium hydroxide (2.7 g) in 50% aqueous methanol (40 m*l*) was refluxed for 10 hr. The solution was neutralized with concentrated hydrochloric acid and evaporated to dryness. The dried residue was extracted with hot absolute ethanol. The solvent was removed, and the brown residue was sublimated under a pressure of 5 mmHg at about 150°C; mp 201—203°C (from ethanol-ether) (lit. 306°C). Yield, 222 mg (88%).

Found: C, 57.39; H, 7.91; N, 22.04%. Calcd for $C_6H_{10}ON_2$: C, 57.11; H, 7.99; N, 22.21%.

B) Into a solution of V (30 mg) in 40% aqueous sulfuric acid (1 m*l*), sodium nitrite (20 mg) in water (0.5 m*l*) was slowly added at room temperature. A yellow material separated out from the reaction mixture and was collected by filtration. This yellow material was identified as the nitroso compound by comparison with the authentic sample prepared by the alternative route. The filtrate was neutralized with a sodium hydroxide solution and evaporated to dryness. The residue was extracted with hot ethanol, and the extracts were concentrated to dryness. The sublimation of the residue at 150°C and 5 mmHg gave 15 mg (67%) of VI; mp 201—203°C.

***N*-Nitroso-1, 2-ureylenecyclopentane.** Into an ice-cold solution of VI (63 mg) in 2 N hydrochloric acid (1 m*l*), sodium nitrite (38 mg) in water (1 m*l*) was slowly stirred. After a while, there separated out yellow crystals which were filtered off and dried to give 40 mg of the nitroso compound; mp 126—127°C (dec.), undepressed by admixture with the nitroso compound obtained above. The infrared spectra of the two substances were identical.

Found: C, 46.25; H, 5.87; N, 26.73%. Calcd for $C_6H_9O_2N_3$: C, 46.44; H, 5.85; N, 27.08%.

Ethyl 2-Benzamidocyclopent-1-ene-carboxylate (VIII). To a mixture of VII (5.5 g) and dry pyridine (4.2 m*l*) in dry ether (100 m*l*), added, drop by drop, benzoyl chloride (5.5 g) was under refluxing. The mixture was then further refluxed for 4 hr. After cooling, the reaction mixture was washed with dilute hydrochloric acid and then water, and was dried over sodium sulfate. The removal of the solvent gave a brown solid (4 g). It was recrystallized from aqueous ethanol; mp 107—108°C.

Found: C, 69.48; H, 6.54; N, 5.35%. Calcd for $C_{15}H_{17}O_3N$: C, 69.48; H, 6.61; N, 5.40%.

Ethyl 2-Benzamidocyclopentanecarboxylate (IX). VIII (5.0 g) was hydrogenated for 3 hr over a Raney nickel catalyst under the hydrogen pressure of 60 atm at 50°C. The catalyst was then filtered off, and the filtrate was concentrated to dryness. The recrystallization of the residue from petroleum ether afforded IX (5.0 g); mp 88—89°C.

Found: C, 68.72; H, 7.56; N, 5.45%. Calcd for $C_{15}H_{19}O_3N$: C, 68.94; H, 7.33; N, 5.36%.

When the hydrogenation of VIII was carried out at 60°C, the benzene ring in VIII was also reduced to a cyclohexane ring; mp 107—108°C (from carbon tetrachloride - petroleum ether).

Found: C, 67.56; H, 9.73; N, 5.10%. Calcd for $C_{15}H_{25}O_3N$: C, 67.38; H, 9.43; N, 5.24%.

2-Benzamidocyclopentanecarboxylic Acid Hydrazide (X). A mixture of IX (2.7 g) and 100% hydrazine hydrate (2 m*l*) in absolute ethanol (10 m*l*) was refluxed for 3 hr. The removal of the solvent and hydrazine under reduced pressure gave the hydrazide (2.6 g). It was then recrystallized from chloroform; mp 180.5—181.5°C.

Found: C, 63.40; H, 7.08; N, 16.78%. Calcd for $C_{13}H_{17}O_2N_3$: C, 63.14; H, 6.93; N, 16.99%.

***N*-Benzoyl-1, 2-ureylenecyclopentane (XI).** Into an ice-cold solution of the hydrazide (X) (141 mg) in 2 N hydrochloric acid (1.1 m*l*) there was stirred a solution of sodium nitrite (52 mg) in water (0.5 m*l*), the resulting azide was extracted with cold ethyl acetate. The extracts were washed with water and dried over sodium sulfate. The ethyl acetate solution was refluxed for 3 hr to decompose the azide. After the removal of the solvent, the residue (101 mg) was recrystallized from benzene; mp 172—173°C (lit. 175—176°C).

Found: C, 67.87; N, 6.01; N, 12.04%. Calcd for $C_{13}H_{14}O_2N_2$: C, 67.81; H, 6.13; N, 12.17%.

1, 2-Ureylenecyclopentane (VI). To a solution of XI (100 mg) in methanol (4.5 m*l*), 10% barium hydroxide solution (7 m*l*) was added. The mixture was then refluxed for 3 hr. The solution was neutralized with concentrated hydrochloric acid and evaporated to dryness. The residue was extracted with hot absolute ethanol, and the extracts were concentrated to dryness. The residue was sublimated at 150°C and 7 mm Hg; mp 201—203°C (from ethanol-ether). Yield, 43 mg (75%).

The material was identical in melting point and infrared spectrum with the substance obtained from V.

Found: C, 57.04; H, 8.07; N, 22.19%. Calcd for $C_6H_{10}ON_2$: C, 57.11; H, 7.99; N, 22.21%.

***cis*-Cyclopentane-1, 2-dicarboxylic Acid (XIII).** XII (15 g) was hydrogenated over a Raney nickel catalyst in absolute ethanol (125 m*l*) at about 100°C for 3 hr under a hydrogen pressure of 80 atm. The catalyst was then filtered off, and the filtrate was concentrated to dryness. The residue (15 g) was recrystallized from concentrated hydrochloric acid; mp 139—140°C (lit.5) 140°C).

***cis*-Cyclopentane-1, 2-dicarboxylic Acid Anhydride (XIV).** A mixture of *cis* diacid (XIII) (25 g) and freshly-distilled acetic anhydride (250 m*l*) was refluxed for 9 hr. The excess acetic anhydride was removed under reduced pressure, and the residual oil was distilled at about 120°C under a pressure of 5 mmHg. The distillate solidified in a receiver during the distillation; yield, 15.5 g. An analytical sample was prepared by recrystallization from ether; mp 73.5—74°C (lit.5) 74°C).

***N*-Hydroxy-*cis*-cyclopentane-1, 2-dicarboximide (XV).** A mixture of XIV (2.9 g), hydroxylamine hydrochloride (1.74 g), and sodium carbonate (1.45 g) in water (30 m*l*) was refluxed on an oil bath for one hour. The solution was acidified with hydrochloric acid and extracted twenty times with 20-m*l* portions of chloroform. The extracts were then dried over sodium sulfate. The evaporation of the solvent gave 2.4 g (75%) of the hydroxide (XV); mp 110—111°C (from chloroform - petroleum ether).

Found: C, 54.24; H, 5.88; N, 9.04%. Calcd for $C_7H_9O_3N$: C, 54.19; H, 5.85; N, 9.03%.

***O*-Benzenesulfonyl Compound of XV.** Into a solution of *N*-hydroximide (XV) (10.8 g) in a 10% sodium carbonate solution (56 m*l*), benzenesulfonyl chloride (9.5 m*l*) was mechanically stirred, drop by drop, at room temperature. The stirring was continued for an hour, and then the product which had crystallized out during the reaction was collected; yield 20 g (97%); mp 110—111°C (from methanol).

Found: C, 53.12; H, 4.60; N, 4.92%. Calcd for $C_{13}H_{13}O_5NS$: C, 52.88; H, 4.44; N, 4.74%.

Benzenesulfonate of *cis*-2-aminocyclopentanecarboxylic Acid (XVII). XVI (2 g) was heated in 10% sodium hydroxide (13 m*l*) on a steam bath for an hour. A clear solution was obtained after about ten minutes. The solution was then acidified with concentrated hydrochloric acid and evaporated to dryness under reduced pressure. An organic material was extracted with hot absolute ethanol from the residual solid. The ethanol was removed, and the residue (1.7 g) was used without further purification for the following reaction. Mp 152—154°C (from ethanol-ether). This amino acid was not purified in our experiment because it was difficult to remove the inorganic material (sodium chloride).

Hydrochloride of XVII. A solution of XVI (0.5 g) and triethylamine (0.5 m*l*) in methanol (10 m*l*) was refluxed for an hour, diluted with water, and extracted with ether. The extracts were then dried over sodium sulfate. The removal of the solvent gave a partly solidified material, which was dissolved in a solution of concentrated hydrochloric acid (2.5 m*l*) in water (7 m*l*) and refluxed for an hour on an oil bath. The solution was then concentrated to dryness and the residue was recrystallized from ethanol-ether to give 0.2 g (67%) of XVII; mp 200—201°C.

Found: C, 43.61; H, 7.59; N, 8.60%. Calcd for $C_6H_{12}O_2NCl$; C, 43.51: H, 7.30; N, 8.46%.

Ethyl 2-Benzamidocyclopentanecarboxylate (IX). Crude benzenesulfonate of XVII, obtained from 1.05 g of XVI, was esterified by refluxing it with a mixture of absolute ethanol (20 m*l*), dry benzene (30 m*l*), and *p*-toluenesulfonic acid (0.1 g) for 15 hr in a Soxhlet apparatus containing sodium sulfate in the thimble. The reaction mixture was then concentrated to a small volume (*ca.* 5 m*l*), diluted with water (10 m*l*), and neutralized with sodium bicarbonate. The amino ester thus obtained was extracted with ether (*ca.* 50 m*l*). The dried extracts were refluxed with benzoyl chloride (1.3 m*l*) in the presence of sodium carbonate (3 g) for 3 hr. The ether layer was washed with water and dried over sodium sulfate. The solvent was evaporated to dryness, and the residual brown solid, dissolved in 5 m*l* of chloroform, was chromatographed over alumina. The organic material was eluted with chloroform. After the evaporation of the solvent, the residue (0.45 g) was recrystallized from petroleum ether bp (40—60°C); mp 88—89°C. The melting point of this compound was not depressed by admixture with the substance obtained *via* Route B.

2-Carbethoxy-5-methylcyclopentanone (Ia). Ia (9.6 g) was obtained from ethyl 2-methyladipate (20 g) and metallic sodium (2.1 g) by the method given in "Organec Syntheses" for the preparation of I; bp 106—108°C/11 mmHg.

Ethyl 3-Methyl-2-ureidocyclopent-1-ene-1-carboxylate (IIa). By treating Ia (3 g) with urea (1.3 g) as has been described above for II (method A), IIa (1.8 g) was obtained; mp 170.5—172.5°C (from ethanol).

Found: C, 56.74; H, 7.35; N, 12.94%. Calcd for $C_{10}H_{16}O_3N_2$: C, 56.59; H, 7.60; N, 13.20%.

Ethyl 3-Methyl-2-ureidocyclopentanecarboxylate (IIIa) and (IIIb). IIa (590 mg) was reduced over a Raney nickel catalyst for 3 hr in absolute ethanol (50 m*l*) at 70°C and under a hydrogen pressure of 80 atm; the solution was then evaporated. The residue (530 mg) was fractionally recrystallized from chloroform-cabon tetrachloride to give IIIa (350 mg) as the first crop. This crude IIIa was then recrystallized from chloroform - carbon tetrachloride; mp 146—148°C.

Found: C, 55.82; H, 8.10; N, 12.92%. Calcd for $C_{10}H_{18}O_3N_2$: C, 56.05; H, 8.47; N, 13.08%.

The chloroform - carbon tetrachloride solution was evaporated to dryness, and the residue was recrystallized from chloroform - petroleum ether (bp 40—60°C). The yield of IIIb was 90 mg; mp 100—102°C.

Found: C, 56.25; H, 8.30; N, 12.90%. Calcd for $C_{10}H_{18}O_3N_2$: C, 56.05; H, 8.47; N, 13.08%.

When the hydrogenation of IIa was carried out at 20°C and 80 atm for 6 hr, IIIa was obtained in a quantitative yield, while IIIb was not observed.

3-Methyl-2-ureidocyclopentanecarboxylic Acid Hydrazide (IVa). *cis-cis*-Compound IIIa (80 mg) and hydrazine hydrate (0.1 m*l*) were worked up in the usual manner. White crystals (65 mg) were thus obtained; mp 172—174°C (from ethanol - carbon tetrachloride).

Found: C, 47.80; H, 8.13; N, 27.80%. Calcd for $C_8H_{16}O_2N_4$: C, 47.98; H, 8.05; N, 27.98%.

3-Methyl-*N*-carbamoyl-1, 2-ureylenecyclopentane (Va). Into a solution of IVa (310 mg) in ice-cold 2 N hydrochloric acid (12 m*l*), sodium nitrite (160 mg) in water (3 m*l*) was stirred; the solution was

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5) S. F. Birch, R. A. Dean, N. J. Hunter and E. V. Whitehead, *J. Org. Chem.*, **20**, 1178 (1955).

then worked up in the usual manner. The crude product was sublimated at about 150°C under a pressure of 5 mmHg; yield 160 mg (57%); mp 190—192°C (from chloroform - petroleum ether bp 40—60°C).

Found: C, 52.66; H, 6.90; N, 22.56%. Calcd for $C_8H_{13}O_2N_3$: C, 52.44; H, 7.15; N, 22.94%.

3-Methyl-1, 2-ureylenecyclopentane (VIa). A solution of Va (160 mg) in a 10% barium hydroxide solution (15 m*l*) and methanol (15 m*l*) was refluxed for 15 hr. The solution was then worked up in the usual manner. The sublimation of the crude material at about 150°C, under a pressure of 5 mmHg, gave 60 mg of VIa; mp 212—213°C (from chloroform-petroleum ether).

Found: C, 59.85; H, 8.67; N, 19.78%. Calcd for $C_7H_{12}ON_2$: C, 59.97; H, 8.63; N, 19.99%.

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