was removed. Yellow crystals soon appeared, and were filtered off and washed with ethanol. Attempts to dissolve the crystals with chloroform or acetone were unsuccessful, so that the product was not recrystallized; wt. 11.5 mg. $[\alpha]^{26}D$ +97° (*c* 0.25 pyridine). When placed on a hot-stage at 270° and the temperature was raised at 5°/minute, the compound darkened at 284°, became black and melted suddenly at 288° dec.

Anal. Calcd. for $C_{20}H_{16}O_{10}N_2$: N, 6.30. Found: N, 6.11.

l-**Dinitroepiasarinin.**—In the same manner as described above 9.8 mg. of *l*-epiasarinin yielded yellow crystals of *l*-dinitroepiasarinin weighing 7.4 mg. Its melting point, when determined in the same way as that of its racemate, darkened at 281°, blackened and melted at 283–285° dec., $[\alpha]^{26}D$ −100° (*c* 0.25 pyridine).

Anal. Calcd. for $C_{20}H_{16}O_{10}N_2$: N, 6.30. Found: N, 6.19.

dl-**Epiasarinin.**—Equal weights of the racemates were heated in ethanol and permitted to crystallize, m.p. 145–147°. Recrystallization did not change the melting point.

dl-**Dibromoepiasarinin.**—Equal weights of the enantiomorphs were dissolved in a small amount of chloroform. Ethanol was added and the solution was evaporated to a small volume. Small needles came out of solution, m.p. 191–193°. The melting point remained unchanged on recrystallization from ethanol.

dl-**Dinitroepiasarinin.**—Equal weights of the racemates were dissolved in hot chloroform and concentrated to a small volume. A small amount of ethanol was added and crystals appeared. The compound was recrystallized and its melting point was determined in the same way as that of its constituent racemates. The crystals started to darken gradually above 288°, were quite dark at 296°, but were still unmelted at 300°.

BELTSVILLE, MD.

[CONTRIBUTION FROM THE ENTOMOLOGY RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE]

Pellitorine Isomers. III. The Synthesis of N-Isobutyl-*trans*-4-*trans*-6-decadienamide and the Structure of Spilanthol[1]

BY MARTIN JACOBSON

RECEIVED MAY 2, 1956

The accepted structure of spilanthol, the pungent, insecticidal constituent of the flower heads of several species of *Spilanthes*, has been N-isobutyl-4,6-decadienamide (geometrical configuration unknown). The *trans,trans* form of this compound has now been synthesized by a stereospecific procedure and found to have different properties from those of the natural material. These properties and several discrepancies in the spectral data and degradative behavior reported for spilanthol cast doubt on the correctness of the gross structure assigned to the latter. An attempt to isolate spilanthol from an American species of *Spilanthes* was unsuccessful. N-Isobutyl-*trans*-2-*trans*-4-octadienamide, related to pellitorine, has been prepared and found to be a powerful sialogog with limited insecticidal activity.

The flower heads of several species of *Spilanthes* (family *Compositae*) contain a pungent principle which has been used medicinally. It was first obtained in the crude state from *S. oleracea* Jacq. by Gerber,[2] who designated it "spilanthol." The same crude material was obtained by Asahina and Asano[3] as a reddish-brown sirup which could not be distilled without decomposition. Hydrolysis gave isobutylamine and polymerized acidic material, while hydrogenation yielded N-isobutylcapramide, b.p. 171° (6 mm.), m.p. 37–38°. Asano and Kanematsu[4] claimed the isolation of pure spilanthol from the flower heads of *S. acmella* L. as a pale yellow, pungent liquid boiling at 165° at 1 mm., which analyzed for $C_{14}H_{25}NO$ and absorbed 2 moles of hydrogen to give N-isobutylcapramide. Ozonization of the liquid resulted in formic and succinic acids and a compound thought to be valeric acid. On the basis of these results, Asano and Kanematsu postulated an allenic structure (I) for spilanthol.

$$CH_3CH_2CH_2CH_2CH{=}C{=}CHCH_2CH_2CONHCH_2CH(CH_3)_2 \quad (I)$$

After further investigation of the ozonization products, these investigators[5] claimed the isolation of formic, succinic and butyric acids (based on Duclaux values), and reported the formation, in very poor yield, of a spilanthol–maleic anhydride adduct, m.p. 167–168°. They accordingly discarded structure I and assigned structure II (N-isobutyl-4,6-decadienamide) to spilanthol.

$$CH_3CH_2CH_2CH{=}CHCH{=}CHCH_2CH_2CONHCH_2CH(CH_3)_2 \quad (II)$$

In 1945, Gokhale and Bhide[6] obtained spilanthol from an Indian variety of *S. acmella* as a pale yellow liquid, b.p. 220–225° (20 mm.); this material formed a maleic anhydride adduct, m.p. 168–169°, in undisclosed yield, and yielded succinic acid on permanganate oxidation in acetone. According to Aihara,[7] natural spilanthol absorbs in the ultraviolet at 220 mμ (undisclosed intensity). Nothing has been reported concerning the geometrical configuration of this compound.

Spilanthol has been reported to be effective against the larvae of *Anopheles*[8] and *Culex* mosquitoes.[9] This was of interest in view of the insecticidal activity of a number of other natural, unsaturated sialogogs,[10] particularly those isolated from the *Compositae*, and prompted an investigation into the possible synthesis of spilanthol.

There are four possible stereoisomers of the diene II. The facile distillation of natural spilanthol

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[1] Part I, M. Jacobson, THIS JOURNAL, **72**, 1489 (1950); part II, **75**, 2584 (1953).

[2] E. Gerber, *Arch. Pharm.*, **241**, 270 (1903).

[3] Y. Asahina and M. Asano, *J. Pharm. Soc. Japan*, **40**, 503 (1920); **42**, 85 (1922).

[4] M. Asano and T. Kanematsu, *ibid.*, **47**, 521 (1927).

[5] M. Asano and T. Kanematsu, *Ber.*, **65B**, 1602 (1932).

[6] V. G. Gokhale and B. V. Bhide, *J. Indian Chem. Soc.*, **22**, 250 (1945).

[7] T. Aihara, *J. Pharm. Soc. Japan*, **70**, 43 (1950).

[8] G. S. Pendse, *et al.*, *Current Sci. (India)*, **14**, 37 (1945); *J. Univ. Bombay*, **15A**, New Ser. Pt. 3, No. 20, 26 (1946).

[9] T. Aihara and T. Suzuki, *J. Pharm. Soc. Japan*, **71**, 1323 (1951).

[10] See L. Feinstein and M. Jacobson, *Fortschr. Chem. Org. Naturstoffe*, **10**, 423 (1953), for a review of the subject.

above 200° with very little decomposition indicated uncommon stability for a compound of this structure, and this, together with the formation of a crystalline maleic anhydride adduct, suggested the *trans* configuration for both double bonds.[11] However, the position of its maximal absorption (220 mμ)[7] is at appreciably shorter wave lengths than is usual for a conjugated diene grouping in the isobutylamides—*e.g.*, 228.5 mμ for affinin,[12] 231 mμ for N-isobutyl-4,6-octadienamide.[13] Also oxalic acid, not succinic acid, would be expected from the oxidation of a compound of structure II. If the gross structure proposed by Asano and Kanematsu is correct, these anomalies are inexplicable. In an attempt to shed some light on the problem the synthesis of N-isobutyl-*trans*-4-*trans*-6-decadienamide was undertaken. The steps employed in this synthesis are shown in the chart below.

The previously prepared isobutylamide of *trans*-2-*trans*-4-decadienoic acid[14] had proved to be both pungent and toxic to adult house flies, while the isobutylamide of *trans*-2-*trans*-4-dodecadienoic acid[11b] was only weakly pungent and completely inactive toward these insects. The isobutylamide of the closely related acid III was therefore prepared for insecticidal evaluation. It proved to be highly pungent, and in tests against house flies[15] exhibited rapid knockdown, although the mortality was low.

Synthetic (all-*trans*) II distilled as a pale yellow, viscous liquid which rapidly solidified to colorless needles, whose properties are shown in Table I. Several attempts to prepare a crystalline maleic anhydride adduct were unsuccessful, an oily reaction product being obtained. In contrast to natural spilanthol, the synthetic material was very weakly pungent and it was completely inactive toward house flies.[15] It was stable at room temperature for about 2 weeks, turning gummy after this time. It appears to be stable indefinitely when kept in the cold (5–10°).

The compound was shown to have structure II by hydrogenation with platinum oxide to N-isobutylcapramide, and by oxidation to yield butyric, oxalic and N-isobutylsuccinamic acids in excellent yields. These degradation products are those which would be expected from the permanganate oxidation of a compound of structure II. No succinic acid could be detected. The infrared spectrum of all-*trans*-II shows a single strong band at 984 cm.$^{-1}$ in conformity with that shown by a conjugated *trans*, *trans* linkage.[16]

After this work was completed, a publication by Yoshioka[17] describing independent work along similar lines came to our attention. In an attempt to prepare natural spilanthol, this investigator condensed ethyl 5-formyl-4-pentenoate with butyl iodide to obtain ethyl 6-hydroxy-4-decenoate, which on conversion to the methyl ester and dehydration gave methyl 4,6-decadienoate, b.p. 103–105° (5 mm.). Saponification of the ester gave a compound boiling at 187–189° (bath temperature) at 3 mm., m.p. 45–50°, designated by Yoshioka as 4,6-decadienoic acid (geometrical configuration undetermined). The isobutylamide prepared from this acid consisted of colorless needles which absorbed 2 moles of hydrogen to give isobutylcapramide, analyzed for $C_{14}H_{25}NO$, and was mildly pungent. As its properties, shown in Table I, obviously did not agree with those of natural spilanthol, it was designated "isospilanthol" by Yoshioka and considered to be a geometric isomer of the natural compound. In spite of the discrepancy in the physical constants of the acid and isobutylamide as reported by Yoshioka and by this Laboratory, we believe "isospilanthol" to be somewhat impure N-isobutyl-*trans*-4-*trans*-6-decadienamide. Unfortunately, no spectral data were reported by Yoshioka, and a sample of his material is not available for comparison.

TABLE I

COMPARISON OF PROPERTIES OF SPILANTHOL, ISOSPILANTHOL AND ALL-*trans*-II

Compound	B.p., °C.	Mm.	M.p., °C.	λ_{max}, mμ	Pungency
Spilanthol[a]	165	1.0	..	220[b]	Strong
	220–225	20			
Isospilanthol[c]	.....		53	..	Weak
All-*trans*-II	156	1.5	60	231	Weak

[a] References 4 and 6. [b] Reference 7. [c] Reference 17.

Extraction of a sample of the flower heads of an American species of *Spilanthes*, *americana* var. *repens*,[18] and fractionation of the resulting extrac-

$$CH_3(CH_2)_2CH{=}CHCHO \xrightarrow[C_5H_5N\ \ 24\%]{CH_2(COOH)_2}$$

$$\underset{\text{III}}{CH_3(CH_2)_2CH{=}CHCH{=}CHCOOH} \xrightarrow[73\%]{LiAlH_4}$$

$$\underset{\text{IV}}{CH_3(CH_2)_2CH{=}CHCH{=}CHCH_2OH} \xrightarrow[66\%]{PBr_3}$$

$$\underset{\text{V}}{CH_3(CH_2)CH{=}CHCH{=}CHCH_2Br} \xrightarrow[67\%]{CHNa(COOC_2H_5)_2}$$

$$\underset{\text{VI}}{CH_3(CH_2)_2CH{=}CHCH{=}CHCH_2CH(COOC_2H_5)_2} \xrightarrow[2,\ HCl\ \ 35\%]{1,\ KOH}$$

$$\underset{\text{VII}}{CH_3(CH_2)_2CH{=}CHCH{=}CHCH_2CH(COOH)_2} \xrightarrow[64\%]{160°}$$

$$\underset{\text{VIII}}{CH_3(CH_2)_2CH{=}CHCH{=}CH(CH_2)_2COOH}$$

$$\xrightarrow[87\%]{SOCl_2} \underset{\text{IX}}{CH_3(CH_2)_2CH{=}CHCH{=}CH(CH_2)_2COCl}$$

$$\xrightarrow[90\%]{\text{isobutylamine}} \text{all } trans\text{-II}$$

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[11] The Diels–Alder reaction invariably fails or proceeds very poorly when the conjugated diene contains a *cis* bond. See (a) W. D. Celmer and I. A. Solomons, THIS JOURNAL, **75**, 1372 (1953); (b) M. Jacobson, *ibid.*, **76**, 4606 (1954); (c) L. Crombie, *J. Chem. Soc.*, 1007 (1955).

[12] F. Acree, Jr., M. Jacobson and H. L. Haller, *J. Org. Chem.*, **10**, 236, 449 (1945).

[13] M. Jacobson, THIS JOURNAL, **77**, 2461 (1955), and unpublished report.

[14] M. Jacobson, *ibid.*, **75**, 2584 (1953).

[15] The tests against house flies were made by W. A. Gersdorff and P. G. Piquett.

[16] J. E. Jackson, *et al.*, *J. Am. Oil Chemists' Soc.*, **29**, 229 (1952); R. R. Allen, *J. Org. Chem.*, **21**, 143 (1956).

[17] T. Yoshioka, *J. Pharm. Soc. Japan*, **75**, 622 (1955).

[18] This material was very kindly collected in Liberty, Texas, by H. R. Reed, of Sonora, Texas.

tive yielded a trace of yellow oil which could not be identified as spilanthol. It was mildly pungent, and exhibited some knockdown but no mortality in tests against house flies.[15]

In the light of these results, we believe that the nature of natural spilanthol remains open and further study of this material is in order.

Experimental[19]

***trans*-2-*trans*-4-Octadienoic Acid (III).**—2-Hexenal[20] (250 g., 2.54 moles) was added, with ice-cooling and stirring, to a solution of 250 g. (2.40 moles) of malonic acid in 400 g. of dry pyridine. No solid formation was noted. The mixture was allowed to stand at room temperature for 72 hours and then heated on the steam-bath for one hour. The solution was poured into 850 ml. of water, and the separated oily layer was poured into 815 ml. of ice-cold 25% hydrochloric acid. The oily solid which separated was filtered off, and washed with water and then with *n*-pentane. Recrystallization from petroleum ether (b.p. 60–70°) gave 80.1 g. (24%) of colorless leaflets, m.p. 76°, with marked electrostatic properties.[21]

Anal. Calcd. for $C_8H_{12}O_2$: C, 68.54; H, 8.63; neut. equiv., 140.2. Found: C, 68.41; H, 8.53; neut. equiv., 138.9.

N-Isobutyl-*trans*-2-*trans*-4-octadienamide.—To a suspension of 4.55 g. (0.033 mole) of the acid III in 20 ml. of dry petroleum ether (b.p. 30–40°) was added 5.8 g. (50% excess) of purified thionyl chloride. The solid quickly went into solution which was allowed to stand overnight at room temperature and was then refluxed on the steam-bath for 1 hour. After removal of the solvent and excess thionyl chloride under reduced pressure, the residual yellow liquid was dissolved in 10 ml. of anhydrous ether and added slowly, with shaking, to an ice-cold solution of 9.2 g. (100% excess) of isobutylamine in 75 ml. of anhydrous ether. After the mixture had stood at room temperature for 1 hour, the precipitated amine hydrochloride was dissolved by the addition of cold dilute hydrochloric acid, and the ether was washed with water, 10% potassium hydroxide solution, and water, then dried and evaporated to dryness. The white solid remaining was recrystallized from petroleum ether (b.p. 60–70°) to give 5.20 g. (81%) of clusters of colorless needles, m.p. 94°, λ_{max} 258.5 mμ in 95% ethanol (ϵ 32,100).

Anal. Calcd. for $C_{12}H_{21}NO$: C, 73.79; H, 10.84; N, 7.17. Found: C, 73.85; H, 10.85; N, 7.02.

The substance was a potent sialogog, but in tests against adult house flies[15] it gave low mortality although exhibiting rapid knockdown.

***trans*-2-*trans*-4-Octadien-1-ol (IV).**—To a solution of 27.6 g. (0.73 mole, 15% excess) of lithium aluminum hydride in 1300 ml. of anhydrous ether was added, with stirring, a solution of 75.5 g. (0.54 mole) of 2,4-octadienoic acid (III) in 500 ml. of anhydrous ether. When addition was complete (3.5 hours), the mixture was cooled in an ice-bath and water was added carefully, followed by 1 liter of 10% sulfuric acid. The separated ether layer was washed with water and dried over sodium sulfate. Removal of the solvent and distillation of the residue gave 49.7 g. (73%) of colorless, mobile liquid with a pleasant, fruity odor, b.p. 70–73° (2 mm.), n^{25}D 1.4865.

Anal. Calcd. for $C_8H_{14}O$: C, 76.12; H, 11.19. Found: C, 75.95; H, 11.09.

***trans*-2-*trans*-4-Octadienyl Bromide (V).**—To a solution of 39.1 g. (10% excess) of phosphorus tribromide and 2 drops of pyridine in 90 ml. of anhydrous *n*-pentane, cooled in an ice–salt-bath, was added slowly, with stirring, a solution of 49.7 g. (0.39 mole) of the alcohol IV and 10 g. of pyridine in 90 ml. of anhydrous pentane. After addition was complete (1.5 hours), the mixture was stirred at room temperature for 1 hour, and the decanted solution was washed with cold water, cold 5% sodium bicarbonate solution, and water, and dried over sodium sulfate. The solution was freed of solvent under reduced pressure and the residue was distilled, giving, after a small forerun (b.p. 40–50° at 1.2 mm.), 48.3 g. (66%) of yellow liquid, b.p. 53° (1.2 mm.), n^{25}D 1.5205, possessing a sharp odor.

Anal. Calcd. for $C_8H_{13}Br$: C, 50.83; H, 6.88; Br, 42.28. Found: C, 51.01; H, 6.92; Br, 42.41.

Diethyl *trans*-2-*trans*-4-Octadienylmalonate (VI).—To 150 ml. of absolute ethanol, protected from atmospheric moisture, was added, with stirring, 6.9 g. (0.3 atom) of sodium in small portions. The solution of sodium ethylate was cooled to 60°, and 49.0 g. (0.31 mole) of diethyl malonate was added in a steady stream from a dropping funnel, followed by 48.2 g. (0.26 mole) of the bromide V added slowly. The solution turned cloudy, a white solid separated, and the temperature of the mixture rose gradually to 76°. After addition was complete (8 minutes), the mixture was refluxed for 3 hours, freed of most of the alcohol by distillation, and stirred with 150 ml. of water. After separation of the layers, the aqueous layer was washed with several small portions of ether, and the combined ether solutions were washed with water and dried over sodium sulfate. Removal of solvent and distillation of the residue gave the desired product (46.4 g., 67%) as a colorless, nearly odorless liquid, b.p. 123–125° (1 mm.), n^{25}D 1.4662.

Anal. Calcd. for $C_{15}H_{24}O_4$: C, 67.14; H, 9.01. Found: C, 67.24; H, 8.95.

***trans*-2-*trans*-4-Octadienylmalonic Acid (VII).**—Diethyl octadienylmalonate (VI) (46.0 g., 0.17 mole) was added in a slow stream, with stirring, to a solution of 34.0 g. (75% excess) of potassium hydroxide in 50 ml. of water. After addition was complete, the clear orange solution was stirred at room temperature for 23 hours, extracted once with ether to remove neutral materials, and made acid to congo red with ice-cold 20% hydrochloric acid. The acid solution was extracted with three 100-ml. portions of ether, and the combined ether solution was washed with water and dried over sodium sulfate. Removal of the solvent left 39.4 g. of sticky, yellowish-white solid, which was recrystallized from benzene–petroleum ether (b.p. 60–70°), giving 12.5 g. (35%) of colorless needles, m.p. 108°.

Anal. Calcd. for $C_{11}H_{16}O_4$: C, 62.25; H, 7.60; neut. equiv., 106.1. Found: C, 62.18; H, 7.50; neut. equiv., 105.6.

***trans*-4-*trans*-6-Decadienoic Acid (VIII).**—Octadienylmalonic acid (VII) (12.0 g.) was heated in an oil-bath at 160° for 3 hours; after cooling, sodium bicarbonate solution was cautiously added till the solution was basic to litmus. The solution was extracted once with ether to remove neutral materials, then acidified to congo red with 20% hydrochloric acid solution and extracted with three 75-ml. portions of ether. The combined ether solution was washed with water, dried over sodium sulfate, and freed of solvent. Distillation of the residue gave 6.5 g. (64%) of colorless, viscous liquid, b.p. 138° (4 mm.), which rapidly solidified to a mass of needles, m.p. 39°.

Anal. Calcd. for $C_{10}H_{16}O_2$: C, 71.39; H, 9.59; neut. equiv., 168.2. Found: C, 71.51; H, 9.68; neut. equiv., 167.5.

***trans*-4-*trans*-6-Decadienoyl Chloride (IX).**—To a solution of 6.4 g. (0.039 mole) of the acid VIII in 25 ml. of dry *n*-pentane was added 6.9 g. (50% excess) of purified thionyl chloride. The solution was allowed to stand overnight at room temperature, and was then refluxed on the steam-bath for 1 hour. After removal of the solvent and excess thionyl chloride under reduced pressure, the residue was distilled to give 6.3 g. (87%) of colorless, mobile liquid, b.p. 80° (1.8 mm.), n^{25}D 1.4895.

Anal. Calcd. for $C_{10}H_{15}ClO$: Cl, 19.00. Found: Cl, 18.89.

N-Isobutyl-*trans*-4-*trans*-6-decadienamide (All-*trans*-II).—To an ice-cold solution of 9.8 g. (100% excess) of redistilled isobutylamine in 100 ml. of anhydrous ether was added slowly, with shaking, an anhydrous ether solution of the acid chloride prepared above. After the mixture had stood at room temperature for 2 hours, the precipitated amine hydrochloride was dissolved by the addition of cold 5% hydrochloric acid solution, and the ether layer was washed with water, 5% sodium hydroxide solution and water, then dried and evaporated. Distillation of the residue yielded

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[19] All melting points are corrected; boiling points are uncorrected.

[20] The receipt of a generous sample of this material from Carbide and Carbon Chemicals Co., South Charleston, W. Va., is gratefully acknowledged.

[21] The 2,4-octadienoic acid, m.p. 74°, of unidentified configuration reported by R. Kuhn and M. Hoffer, *Ber.*, **65B**, 170 (1932), was thus undoubtedly *trans,trans*.

6.6 g. (90%) of pale yellow, viscous oil, b.p. 156° (1.5 mm.), which rapidly solidified to a mass of colorless needles, m.p. 60°, λ_{max} 231 mμ in 95% ethanol (ϵ 29,250).

Anal. Calcd. for $C_{14}H_{25}NO$: C, 75.28; H, 11.28; N, 6.27. Found: C, 75.19; H, 11.29; N, 6.27.

Reaction of All-*trans*-II with Maleic Anhydride.—All-*trans*-II (100 mg.), maleic anhydride (40 mg.) and benzene (0.8 ml.) were sealed under nitrogen and heated at 100° for 17 hours. On cooling to 5°, a viscous yellow oil separated which could not be induced to crystallize. Evaporation of the benzene gave only a resin.

All-*trans*-II (1 g.), heated at 100° with 0.75 g. of maleic anhydride for 1 minute and then cooled, gave a viscous, orange oil. This was digested with ether (an orange resin remained insoluble); the ether-soluble extractive was a viscous, yellow oil which would not crystallize.

Hydrogenation of All-*trans*-II.—An ethanol solution of 0.2064 g. of all-*trans*-II was hydrogenated with 50 mg. of reduced platinum oxide catalyst. In 15 minutes 42.8 ml. (cor.) of hydrogen was taken up and the reaction then ceased. (The theoretical requirement for 2 moles of hydrogen for this weight of a substance of molecular weight 223 is 41.5 ml.) The reaction mixture was separated from the catalyst, and the solvent was removed at reduced pressure, leaving 210 mg. of a colorless oil which crystallized in rosettes of needles, m.p. 37.5–38.0°, identical with N-isobutylcapramide, m.p. and mixed melting point 37.5–38.0°.

Oxidation of All-*trans*-II.—One gram of all-*trans*-II suspended in 100 ml. of water maintained at 50–60° was treated, with stirring, with 3.8 g. of finely powdered potassium permanganate added in small portions. When the reaction mixture had become colorless, the manganese dioxide was filtered off and washed thoroughly with warm water. The combined aqueous filtrates were concentrated down to 10 ml. and made acid to congo red with sulfuric acid. The solution was steam distilled to remove the volatile acids and then extracted with ether for 4 days in a continuous extractor. The ether solution was freed of solvent, and the residue was taken up in chloroform and kept at 0° overnight. The crystals which separated were subjected to sublimation in a microsublimator, yielding 277 mg. (70%) of colorless solid, which sublimed at 100–105° (15 mm.) and melted at 185–186° dec. It rapidly reduced an aqueous solution of potassium permanganate, and was identified as anhydrous oxalic acid by a mixed melting point determination with an authentic specimen (m.p. 186–187° dec.).

The chloroform solution was evaporated to dryness and the yellowish solid residue was recrystallized from benzene, giving 564 mg. (74%) of feathery needles, m.p. 92.0–92.5°, which were very soluble in water.

Anal. Calcd. for $C_8H_{15}NO_3$: C, 55.47; H, 8.73; N, 8.08. Found: C, 55.42; H, 8.51; N, 8.15.

The product was identical with N-isobutylsuccinamic acid, m.p. 92.0–92.5°, by mixed melting point with an authentic specimen prepared by the following procedure. A refluxing mixture of 54 g. of succinic anhydride and 200 ml. of anhydrous ether was treated dropwise with 41 g. of isobutylamine; lumps of white solid which gradually formed were broken up from time to time. The mixture was refluxed for 2 days, cooled, and filtered, and the oily solid was recrystallized thrice from benzene to give 62.1 g. (65%) of long, feathery needles, m.p. 92.0–92.5°.

The solution of steam-volatile acids obtained above was neutralized with sodium hydroxide solution, concentrated to a small volume on the steam-bath, and acidified to congo red with sulfuric acid. The solution was rapidly steam distilled until all material acid to congo red had distilled over. The distillate was neutralized with dilute sodium hydroxide solution, the neutral solution was evaporated to dryness, and the *p*-phenylphenacyl ester was prepared. It melted at 82° and a mixed melting point determination with authentic *p*-phenylphenacyl butyrate, m.p. 82°, showed no depression.

The distilland above was neutralized with sodium hydroxide solution, concentrated to a very small volume on the steam-bath, acidified to congo red with sulfuric acid, and extracted with ether in a continuous extractor for 3 days. The ether solution was dried and freed of solvent, yielding an additional 15 mg. of N-isobutylsuccinamic acid.

Examination of *Spilanthes americana* Flower Heads.—The finely ground flower heads (962 g.) were extracted in a soxhlet extractor overnight with petroleum ether (b.p. 30–40°). The extract was concentrated to 250 ml. and extracted with three 75-ml. portions of nitromethane. The combined nitromethane solution was freed of solvent under reduced pressure, the residue was taken up in ethyl ether, and the ether solution was washed with water, 5% hydrochloric acid solution, 5% sodium hydroxide solution and water, and dried over sodium sulfate. Removal of solvent under reduced pressure left 10 mg. of a yellow oil which could not be induced to crystallize. It was very weakly pungent and, although showing some knockdown when tested against adult house flies,[15] it caused no mortality of these insects.

BELTSVILLE, MARYLAND

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY OF CORNELL UNIVERSITY]

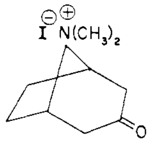
Elimination Reactions of Bicyclic Quaternary Salts. II. The Base Degradation of Pseudopelletierine Methiodide

BY J. MEINWALD AND S. L. EMERMAN

RECEIVED APRIL 9, 1956

The base degradation product of pseudopelletierine methiodide (II) is shown to be a *mixture* of acetophenone and 1-cyclohexenyl methyl ketone rather than a dihydroacetophenone as previously considered. In explanation of these results, a reaction sequence involving (1) formation of a cycloöctadienone III, (2) conversion of this intermediate into a cyclohexadienyl methyl ketone IX, and (3) a hydrogen exchange reaction, is suggested and discussed in detail.

The claim that tropinone methiodide (I) is transformed by a variety of bases into dimethylamine and a dihydrobenzaldehyde has recently been discredited,[1] and it is now clear that no rearrangement accompanies this elimination reaction. We have now reinvestigated the behavior of the closely related alkaloid derivative pseudopelletierine methiodide (II), which has been reported to undergo a ring contraction on treatment with strong base, giving rise to dimethylamine and a *dihydroacetophenone*.[2] The results of these studies provide the subject of the present communication.



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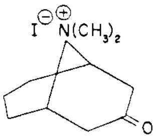
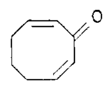


II



III

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(1) J. Meinwald, S. L. Emerman, N. C. Yang and G. Büchi, THIS JOURNAL, **77**, 4401 (1955).

(2) G. Ciamician and P. Silber, *Ber.*, **25**, 1601 (1892); *Gazz. chim. ital.*, **22** (II), 514 (1892); *Ber.*, **26**, 156 (1893).