(10 g, 0.054 mole) and anhydrous *unsym*-dimethylhydrazine (10 g, 0.167 mole) in anhydrous ethanol was refluxed 4 hr. Excess dimethylhydrazine and ethanol were removed with a vacuum evaporator to give a yellow solid residue. This was recrystallized from ethyl acetate to give 1,3-dimethyl-5-nitro-1H-indazole (8.1 g, 0.0425 mole) in 78% yield, mp 164.5–165.5°. The pmr spectrum shows phenyl protons at τ ~3 and two singlets at τ 5.95 and 7.28 with equal intensities.

Anal. Calcd for $C_9H_9N_3O_2$: C, 56.53; H, 4.75; N, 21.98. Found: C, 56.66; H, 4.77; N, 22.08.

1,3-Dimethyl-5-nitro-1H-indazole (from Methylhydrazine).—A mixture of 2′-chloro-5′-nitroacetophenone (1.0 g, 0.0054 mole) with anhydrous methylhydrazine (5 ml) in absolute ethanol (15 ml) was refluxed 5 hr. Excess methylhydrazine and ethanol were removed at reduced pressure to give a yellow solid residue. Recrystallization from ethyl acetate gave 1,3-dimethyl-5-nitro-1H-indazole (700 mg) in 80% yield: mp 164–165°. A mixture melting point determination with the 1,3-dimethyl-5-nitro-1H-indazole prepared by using *unsym*-dimethylhydrazine showed no depression; the infrared spectra were identical.

5-Amino-1,3-dimethyl-1H-indazole.—A mixture of 1,3-dimethyl-5-nitro-1H-indazole (2.0 g, 0.0105 mole), 10% palladium on carbon (0.01 g), and 95% ethanol (20 ml) was heated to 50° with stirring and slow addition of anhydrous hydrazine (3 ml) in 1 hr. The catalyst was filtered from the solution and washed with hot ethanol (10 ml). The filtrate was concentrated on a rotary evaporator to give a white solid. Recrystallization from ethanol gave 5-amino-1,3-dimethyl-1H-indazole (1.4 g, 0.0087 mole) in 83.5% yield: mp 170°.

Anal. Calcd for $C_9H_{11}N_3$: C, 67.06; H, 6.88; N, 26.07. Found: C, 66.95; H, 6.75; N, 26.13.

1,3-Dimethyl-1H-indazole. A. Reduction of 5-Amino-1,3-dimethyl-1H-indazole.—A mixture of 5-amino-1,3-dimethyl-1H-indazole (500 mg, 0.0031 mole) in warm dilute hydrochloric acid (5.0 ml, ~5 *N*) was dissolved, then cooled to ~10°. Additional concentrated hydrochloric acid (0.40 ml) was added, followed by a solution of sodium nitrite (1 ml, 30%) over 10 min. The reaction mixture was poured into cold 50% hypophosphorous acid solution (5 ml) and allowed to stand at ~0° for several hours. The solution was made basic with dilute aqueous sodium hydroxide and extracted with diethyl ether (two 50-ml portions). The ether extract was dried with magnesium sulfate and stripped to give 1,3-dimethyl-1H-indazole (200 mg, 0.0013 mole) in 42% yield: mp 34°, bp 58–60° (0.3 mm) (lit.[14] mp 35.5°, bp 240°).

B. From 2′-Bromoacetophenone.—A mixture of 2′-bromoacetophenone (2.0 g, 0.0101 mole) and anhydrous *unsym*-dimethylhydrazine (5 ml, excess) was heated at 80° in a sealed tube for 6 days. The contents were poured into absolute ethanol; a white insoluble solid was filtered, washed with anhydrous ether, and dried, giving N,N,N-trimethylhydrazinium bromide (mp ~250° dec). The filtrate was stripped, giving a pale yellow oil. Fractional distillation gave 1,3-dimethyl-1H-indazole (1.35 g, 0.0092 mole) in 92% yield: bp 59–61° (0.3 mm), $n^{21}D$ 1.5679.

The nmr spectrum exhibited phenyl hydrogens as a complex region at τ 2.8; the methyl groups appeared as two singlets at τ 6.12 ($N-CH_3$) and 7.53 (conjugated $C-CH_3$). The nmr and infrared spectra and physical properties were identical with those obtained above.

Fluorenone Hydrazone.—A mixture of fluorenone dimethylhydrazone (2.0 g, 0.009 mole) in absolute ethanol (10 ml) was refluxed with anhydrous hydrazine (3 g, 0.094 mole) for 12 hr.[24] The mixture was poured into ice–water (10 ml), extracted with diethyl ether (two 20-ml portions), and dried with magnesium sulfate. The solvent was stripped *in vacuo*, giving yellow crystalline fluorenone hydrazone (1.57 g, 0.0081 mole) in 90% yield: mp 146° (lit.[25] mp 148–149°). Recrystallization from ethyl acetate gave mp 149°.

Acknowledgment.—We wish to thank Dr. Peter A. S. Smith for useful criticisms of the original manuscript.

(24) If the reflux time was extended to 48 hr, the yield of the fluorenone hydrazone was drastically reduced. The major isolated product was fluorene in as high as 96% yield: mp 102–103° (recrystallization from benzene). A mixture melting point with an authentic sample of fluorene was undepressed; the infrared spectra were identical.

(25) C. L. Arcus and R. J. Mesley, *J. Chem. Soc.*, 178 (1953).

The Structure of Ambrosiol. A New Sesquiterpene Lactone from *Ambrosia psilostachya*

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The structure of ambrosiol, the major sesquiterpene lactone in an Austin, Texas, collection of *Ambrosia psilostachya*, DC., is shown to be **11**.

The sesquiterpene lactones of *Ambrosia psilostachya*, DC., a common ragweed of the United States, are being analyzed as part of a chemosystematic investigation of *Ambrosia* and related *Compositae* genera. Coronopilin (**1**) was the only sesquiterpene lactone reported by Herz and Högenauer[2] from *A. psilostachya* obtained in Kansas and by Geissman and Turley[3] from *A. psilostachya* collected in the western United States. Our investigation of *A. psilostachya* from Galveston Island, Texas, resulted in the isolation of three structurally closely related sesquiterpenes which belonged to a new class of sesquiterpene dilactones. The structure of one of them, psilostachyin (**2**), has already been described.[4]

No coronopilin (**1**) was detected in the extracts of the Galveston Island material. In view of these differences in the sesquiterpene lactone content of *A. psilostachya* collected from different locations, we initiated a phytochemical survey of a number of widely separated populations of the species. We now report the sesquiterpene lactone constituents of *A. psilostachya* collected near Austin, Texas.

Extraction of the Austin collection of *A. psilostachya* furnished in about 1% yield a new substance, which we have named ambrosiol, and smaller amounts of coronopilin (**1**) and parthenin (**3**). This is the first report of parthenin from this species. Parthenin, whose structure has been previously established,[5] is the major sesquiterpene lactone in *Parthenium hysterophorus*. The presence of parthenin in *A. psilostachya* provides further chemical evidence to

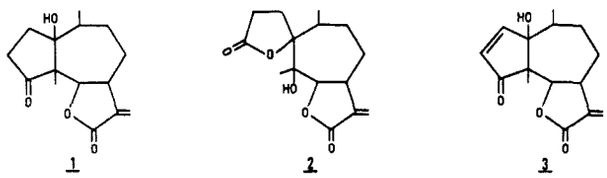
(1) On leave from Laboratoire de Chimie Organique des Hormones, College de France, Paris.

(2) W. Herz and G. Högenauer, *J. Org. Chem.*, **26**, 5011 (1961).

(3) T. A. Geissman and R. J. Turley, *ibid.*, **29**, 2553 (1964).

(4) (a) H. E. Miller, H. B. Kagan, W. Renold, and T. J. Mabry, *Tetrahedron Letters*, **No. 38**, 3397 (1965); (b) T. J. Mabry, H. E. Miller, H. B. Kagan, and W. Renold, *Tetrahedron*, in press.

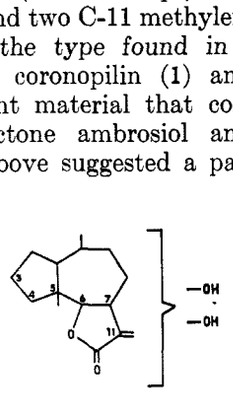
(5) W. Herz, H. Watanabe, M. Miyazaki, and K. Kishida, *J. Am. Chem. Soc.*, **84**, 2601 (1962).



support the close alignment of the two genera, *Parthenium* and *Ambrosia*.[2]

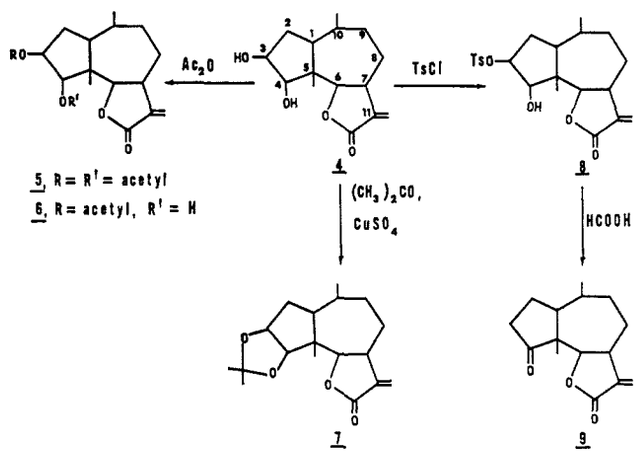
The new compound, ambrosiol (**4**), $C_{15}H_{22}O_4$, mp 116–117°, obviously contained an α,β'-unsaturated γ-lactone [λ_{max} 213 mμ (ϵ 8250), infrared bands at 1750 and 1660 cm^{-1}] and two hydroxyl groups (infrared band at 3400 cm^{-1}, formation of a diacetate). The two hydroxyl groups in **4** were vicinal as evidenced by a positive periodate test and the facile formation of an acetonide derivative.

The nmr spectrum of ambrosiol showed a singlet at 0.78[6] and a doublet at 0.98 (J = 7 cps) for one tertiary and one secondary methyl group, respectively. A doublet, integrating for one proton, at 5.08 (J = 10 cps) and a pair of doublets (intensity one proton each) at 5.46 and 6.15 (J = 3.5 cps) were typical for a lactonic proton and two C-11 methylene group protons, respectively, of the type found in coronopilin (**1**). The presence of coronopilin (**1**) and parthenin (**3**) in the same plant material that contained the new sesquiterpene lactone ambrosiol and the chemical data described above suggested a partial formula for ambrosiol.



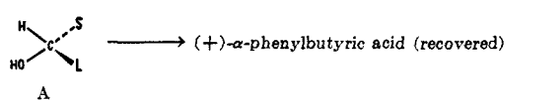
That the two hydroxyl groups are located at C-3 and C-4 in ambrosiol was indicated by the nmr signals observed for the protons on the carbon atoms carrying the hydroxyl groups. A doublet at 3.69 (J = 5 cps) in the nmr spectrum of **4** can be ascribed to the C-4 proton spin coupled to only one proton. A complex signal as 4.33 was assigned to the C-3 proton. Both of these signals were shifted downfield as expected in the spectrum of the diacetate of **4**, the complex C-3 proton signal coming at 5.32 and the doublet for the C-4 proton at 5.02 (J = 4.5 cps). The formation of an acetonide derivative of **4** suggested that the two hydroxyl groups were *cis*.

All of the above data supported structure **4** for ambrosiol. Final proof of structure was provided by the conversion of ambrosiol to a sesquiterpene lactone of known structure, damsin[7] (**9**). When ambrosiol was treated with *p*-toluenesulfonyl chloride, the monotosylate **8** was formed. This compound readily underwent a pinacol rearrangement on refluxing with formic acid. The product was identical in all respects with authentic damsin. Damsin is known to be dihydroambrosin.[7] Herz and co-workers[5] and Geissman and Turley[6] have presented compelling arguments for some of the stereochemical features of tetrahydroparthenin, tetrahydroambrosin, and coronopilin, which



suggest for damsin the stereochemical features shown in **10**. Thus, the conversion of ambrosiol to damsin provided the stereochemical configurations shown in **11** at C-1, -5, -6, -7 and -10.

The stereochemistry at C-3 and C-4 in ambrosiol was established by the method developed by Horeau[8] for determining the configuration of asymmetric centers containing a secondary hydroxyl group. It was observed that secondary hydroxyl groups attached to asymmetric carbon atoms in steroids,[9] for example, reacted stereoselectively in the presence of excess racemic α-phenylbutyric anhydride; that is, the amount of plus *vs.* minus acid that was bound to the steroid was directly related to the absolute configuration at the reaction site. The extent of the stereospecificity of the reaction was, in fact, determined by the optical activity of the α-phenylbutyric acid recovered from the reaction. If the recovered α-phenylbutyric acid is *dextrorotatory*, (+), then the absolute configuration of the alcohol is represented by formula A in which L refers to the sterically large and S to the sterically small substituent.[8,9]



A

When excess racemic α-phenylbutyric anhydride was treated with either ambrosiol (**4**) or ambrosiol 3-monoacetate (**6**), a dextrorotatory optically active acid could be extracted from the reaction solutions with a sodium bicarbonate solution. That both **4** and **6** were totally esterified was evident from the nmr spectra of the products. The optical yield[10] from **6** was about 35%. The amount of dextrorotatory acid recovered from the esterification of **4** indicated that the C-3 hydroxyl group in **4** also gave an optical yield of 35% of dextrorotatory acid based on the assumption that the nature of the O substituent at C-3 does not significantly affect the optical yield for the hydroxyl group at C-4. Based on the Horeau procedure, the C-3 asymmetric center must have the absolute configuration *R*. Therefore, the C-3 hydroxyl group has an α orientation as shown in **11**. The C-4 hydroxyl group can also be assigned an α configuration since the

(6) All chemical shift values are reported in parts per million (δ scale).

(7) M. Suchy, V. Herout, and F. Šorm, *Collection Czech. Chem. Commun.*, **28**, 2257 (1963).

(8) A. Horeau, *Tetrahedron Letters*, **No. 15**, 506 (1961).

(9) A. Horeau, and H. B. Kagan, *Tetrahedron*, **20**, 2431 (1964).

(10) The expression optical yield has been defined[8,9] as the ratio of the observed rotation of the recovered acid with respect to the rotation expected if the esterification was completely stereoselective. Here we used the ratio of the experimental specific rotation to the theoretical value.

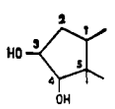
TABLE I

NMR DATA FOR AMBROSIOL DERIVATIVES[a]

Compd	H-3	H-4	H-6	H-7	C-11 CH_2	C5 CH_3	C-10 CH_3	Misc
4	4.33 c	3.69 d (5)	5.08 d (10)	3.40 br	5.46 d (3.5) 6.15 d (3.5)	0.78	0.98 d (7)	
5	5.32 c	5.02 d (4.5)	4.86 d (9)	3.37 br	5.47 d (3.5) 6.16 d (3.5)	0.94	1.02 d (7.5)	1.97[b] 2.11[b]
6	5.08 c	3.90 d (4.5)	5.12 d (10)	3.40 br	5.46 d (3.5) 6.14 d (3.5)	0.82	1.00 d (7)	2.08[b]
7	4.58 c	4.10 d (6)	4.94 d (9.5)	3.38 br	5.45 d (3.5) 6.15 d (3.5)	0.78	0.98 d (7)	1.27[c] 1.46[c]
8	4.82 c	3.79 d (4)	5.10 d (9.5)	3.40 br	5.42 d (3) 6.09 d (3)	0.74	0.91 d (7)	2.39[d] 7.28 d (8.5)[e] 7.78 d (8.5)[e]

[a] All spectra were run on a Varian A-60 spectrometer in $CDCl_3$ and values are given in parts per million relative to internal tetramethylsilane as reference. All signals in the first five columns correspond to one proton; all signals in the last three columns refer to three protons, unless otherwise specified. Singlets are unmarked. Multiplets are described as follows: d, doublet; c, complex; br, somewhat broadened singlet. Numbers in parentheses denote coupling constants in cycles per second. [b] Acetyl. [c] Acetonide methyl. [d] Aromatic methyl. [e] Aromatic protons; each doublet corresponds to two protons.

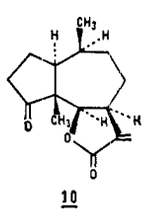
facile acetonide formation indicated a *cis* relationship for the glycol. This is confirmed when Horeau's method is applied to **6** if the assumption is made[11] that the C-5 group (see partial formula B) is the larger



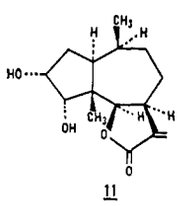
B

of the substituents attached to C-4. Based on this assumption and the fact that **6** produces a dextrorotatory acid, we can conclude that the C-4 hydroxyl group has an α configuration.

Based on all the evidence presented above, we propose structure **11** for ambrosiol.



10



11

Experimental Section[12]

Isolation of Ambrosiol (4).—Several collections of *Ambrosia psilostachya* obtained 5–10 miles west of Austin, Texas, in the fall of 1964 (Nov 7)[13] and 1965 (Aug 28), contained approximately the same distribution of sesquiterpene lactones. The results from a typical extraction are described.

The air-dried ground plant material was extracted with chloroform and worked up in the usual manner.[4] From 100 g of plant material was obtained 2.1 g of a thick syrup. Nmr analysis indicated the presence of 0.22 g (0.22% yield) of coronopilin, 0.18 g (0.18%) of parthenin, and 1.02 g (1.02%) of the new compound, ambrosiol. The mixture was difficult to separate and required several chromatographic runs over silica gel. Coronopilin (**1**) and parthenin (**3**) were usually eluted as a mixture with chloroform, but the first fractions contained mostly coronopilin and the last fractions mostly parthenin. Ambrosiol was obtained when the columns were eluted with chloroform containing 3% methanol. Small samples of analytically pure coronopilin, mp 178–180°, and parthenin, mp 164–166°, were obtained by recrystallization of the fractions which were enriched in them. Both substances were identical in all respects with authentic samples. The ambrosiol obtained by chromatography was purified by sublimation at 140–160° (0.05 mm): mp 116–117°; $[\alpha]^{26}D$ −111.3° (*c* 5.10, $CHCl_3$); λ_{max} 213 mμ (ε 8250), no inflections near 300 mμ; infrared bands ($CHCl_3$), 3400 (–OH), 1750 (γ-lactone), and 1660 cm^{-1} (double bond). Ambrosiol gave a positive periodic acid test.

Anal. Calcd for $C_{15}H_{22}O_4$: C, 67.74; H, 8.33; O, 24.03. Found: C, 67.66; H, 8.50; O, 23.94, mol wt (mass spectrum), 266.

Diacetylambrosiol (5).—Ambrosiol (**4**) (0.1 g) was treated with a solution containing 1 ml of pyridine and 1 ml of acetic anhydride for 24 hr at room temperature. Evaporation of the solution *in vacuo* gave 0.14 g of crystalline material which could be sublimed at 130–160° (0.05 mm) in 70% yield, giving analytically pure diacetylambrosiol: mp 154–155°; infrared bands ($CHCl_3$), 1750, 1660, 1250, and 1220 cm^{-1}. The substance gave a negative periodic acid test.

Anal. Calcd for $C_{19}H_{26}O_6$: C, 65.12; H, 7.48; O, 27.40. Found: C, 65.01; H, 7.39; O, 27.61.

3-Monoacetylambrosiol (6).—A solution of 0.50 g of ambrosiol (**4**) (1.88 mmoles), 1.2 ml of pyridine, and 0.29 g of acetic anhydride (2.84 mmoles) was allowed to stand for 22 hr at room temperature. Thin layer chromatography on silica gel G (chloroform–ethyl acetate, 3:2) indicated the presence of both the monoacetyl- (**6**) and diacetylambrosiol (**5**). Evaporation of the solution *in vacuo* yielded a yellow oil (0.63 g) which was (by nmr) 50% diacetyl-, 40% monoacetylambrosiol, and 10% ambrosiol. Although the mixture could be separated by silica gel chromatography, the monoacetylambrosiol (obtained by elution with chloroform) did not crystallize. The nmr spectrum of the oil was in accord with the presence of one acetyl group at C-3.

Ambrosiol Acetonide (7).—A solution of 0.1 g of **4** in 10 ml of dry acetone, which contained 0.2 g of anhydrous cupric sulfate, was shaken for 58 hr at room temperature. After the mixture was allowed to stand for 10 days, the cupric sulfate was filtered off and the solvent was removed *in vacuo*. The residue (0.13 g), which crystallized on standing, was recrystallized from ether–heptane: mp 134–135°; infrared bands ($CHCl_3$), 1750 and 1660 cm^{-1}. The material showed a parent mass spectrographic peak of 306 which was in agreement with the calculated molecular weight of 306.39 for $C_{18}H_{26}O_4$.

Pinacol Rearrangement of 8.—*p*-Toluenesulfonyl chloride (0.26 g) was added to a solution of 0.3 g of **4** in 0.5 ml of pyridine. The solution was heated for 15 hr at 45°. After 20 ml of water was added, the reaction mixture was extracted with chloroform. The chloroform layer, which was washed with water, dried, and concentrated in the usual manner, yielded a partially crystalline solid (0.47 g). Nmr indicated the presence of the monotosylate of **4, 8,** in better than 90% yield. The material was dissolved in 10 ml of formic acid (97+%) and refluxed.[14] The reaction

(11) In most of the previous applications of Horeau's method, the S substituent (formula A) was always a methylene group. However, for an example where S is a more highly substituted group, see M. Harispe, D. Mea, A. Horeau, and J. Jacques, *Bull. Soc. Chim. France*, 972 (1963).

(12) All melting points are uncorrected. Ultraviolet spectra were determined in absolute methanol solution. Analyses were determined by Dr. Alfred Bernhardt, Max-Planck Institut für Kohlenforschung, Mülheim, West Germany.

(13) Voucher no. 233,510, The University of Texas Herbarium, Austin, Texas.

(14) When ambrosiol was refluxed with formic acid, a diformate was formed quantitatively.

required 24 hr for completion. After evaporation of the solvent *in vacuo*, the residue was dissolved in chloroform, which was subsequently washed with a saturated sodium bicarbonate solution. The chloroform layer was washed with water, dried, and evaporated. The oily residue (0.31 g) was crystallized from methylene chloride–diisopropyl ether, yielding 0.1 g of damsin (**9**), mp 106–107°. The material was identical with authentic damsin by melting point, mixture melting point, thin layer chromatography on silica gel G, and infrared and nmr spectra.

Determination of the Configuration at C-3 and C-4 in 4 by Horeau's Method.[8,9] **A. Esterification of 4.**—Racemic α-phenylbutyric anhydride (464.4 mg, 1.5 mmoles) and 133.3 mg of ambrosiol (0.5 mmoles) were dissolved in 5 ml of pyridine. After this stood at room temperature overnight, 1 ml of water was added to hydrolyze the excess anhydride. After 2 hr about 20 ml of water was added, and the aqueous solution was extracted twice with ethyl acetate. The ethyl acetate extract was washed with water, with a 5% sodium bicarbonate solution (three 10-ml portions), again with water, and finally with 3 *N* HCl. The ethyl acetate solution was dried in the usual manner and then concentrated *in vacuo* to a constant-weight residue, 271 mg. An nmr spectrum of the residue indicated that **4** was totally esterified. The sodium bicarbonate extract obtained above was washed with chloroform before being acidified with excess 3 *N* HCl. A chloroform extract of the acidic solution, worked up in the usual manner, yielded a residue which was dried to constant weight: 298.3 mg of pure α-phenylbutyric acid. The purity was established by nmr spectroscopy. The acid was dissolved in 10 ml of benzene and the specific rotation was determined: $[\alpha]^{24}D$ +17.1°.

B. Esterification of 3-Monoacetylambrosiol (**6**).—Racemic α-phenylbutyric anhydride (178.0 mg, 0.574 mmole) and 86.6 mg (0.281 mmole) of 3-monoacetylambrosiol were dissolved in 2.5 ml of pyridine, and the mixture was allowed to stand overnight at room temperature. The reaction was worked up as described above for ambrosiol. The nmr spectrum of the ethyl acetate fraction (103.4 mg) indicated that the product was totally esterified. The sodium bicarbonate extract yielded 145.1 mg of α-phenylbutyric acid, $[\alpha]^{24}D$ +11.4°. For a 100% optical yield, the recovered acid would have shown $[\alpha]D$ 32.2°, that is, one-third of the specific rotation of pure acid, ±96.5°.[8] The 1/3 factor reflects the fact that in this experiment, of the 3 moles of acid theoretically recovered (relative to 1 mole of **6**), 2 moles are derived from the hydrolysis of the excess racemic anhydride. Therefore, the optical yield is 35% [(11.4/32.2) × 100] in dextrorotatory acid.

C. Calculation of Optical Yield from the C-3 Hydroxyl Group in 4.—In the esterification of **4**, 1.5 mmoles of α-phenylbutyric acid was treated with 0.5 mmole of ambrosiol. One can easily calculate that, of the 2 moles of acid theoretically recovered (relative to 0.5 mole of **4**), one was derived from the hydrolysis of excess racemic anhydride. If both hydroxyl groups in **4** are esterified completely stereoselectively by the same optically active acyl group, then a specific rotation of 48.25° is expected. If the C-3 hydroxyl group were esterified nonstereoselectively, then a specific rotation for the recovered acid should be about +8.5° since the C-4 hydroxyl group reacted in **6** stereoselectively with a 35% optical yield. Since the experimental specific rotation is +17.1°, the C-3 hydroxyl group must have also given a dextrorotatory acid in about 35% optical yield.

Acknowledgments.—T. J. M. thanks the Robert A. Welch Foundation for financial support (Grant F-130); H. B. K. and H. E. M. acknowledge a NATO grant (1965) and an National Institutes of Health predoctoral fellowship (Grant 5T1- GM 789), respectively. We thank Dr. W. Herz, Florida State University, for authentic samples of damsin and parthenin.

Terpenes. II. The Stereochemistry and Absolute Configurations of the Thujylamines and Some Related Compounds[1]

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The absolute configurations of the isomeric thujylamines, (−)-thujylamine (Ia), (−)-neothujylamine (IIa), (+)-isothujylamine (IIIa), and (+)-neoisothujylamine (IVa), characterized as shown in Table I, were deduced on the basis of their preparation from the related thujyl alcohols and thujones. As reported in a preliminary communication and here described and discussed in more detail, the degradation of (−)-umbellulone (VII) to (+)-(*S*)-α-methyl-α-isopropylsuccinic acid (VIII) establishes the absolute configurations of the ring-junction carbon atoms in the thujyl alcohols, thujones, and thujylamines. In the amines, the configurational assignments for the amino and methyl groups depend on the assignments recently established for the hydroxyl and methyl groups in the alcohols and ketones.

In connection with an interest in optically active amines,[1c] our attention was directed toward the establishment of the absolute configurations of the isomeric thujylamines (Ia–IVa, Chart I), formed in the Leuckart reaction on (−)-thujone (V)[3] or by reduction of the oximes of (−)-thujone[4] or (+)-isothujone (VI).[3b,4,5] These amines provide a set of model compounds for study of the optical rotatory dispersion and circular dichroism of amine derivatives.[1c,6] In addition, in view of the extension of the investigation of cations of the proposed "trishomocyclopropenyl" type[7] to the deamination of *cis*- and *trans*-3-bicyclo[3.1.0]-hexylamine,[8] the determination of the absolute configurations of the thujylamines seemed especially important. These amines provide a series of optically active compounds, the deamination of which might afford valuable information concerning the steric and electronic nature of the intermediate cations. This information would augment and extend that already available in a recent report[9] concerning the acetolysis

(1) (a) Taken largely from the Ph.D. Thesis of E. H. M., Vanderbilt University, Jan 1966, and presented in part at the Southeast–Southwest Regional Meeting of the American Chemical Society, Memphis, Tenn., Dec 1965; Abstracts of Papers, p 47. (b) Paper I: H. E. Smith and A. W. Gordon, *J. Am. Chem. Soc.*, **84**, 2840 (1962). (c) This is also paper VI in the series entitled Optically Active Amines. Paper V: H. E. Smith and R. Records, *Tetrahedron*, in press.

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(9) T. Norin, *Tetrahedron Letters*, 37 (1964).