[Chem. Pharm. Bull.
16(10)2090—2091(1968)]

UDC 581.19 : 547.597 : 582.29

Structure of a Lichen Pigment Entothein and Its Identity with Secalonic Acid A, a Major Ergot Pigment

In the previous paper,1) we disclosed the triterpenic component of a lichen *Parmelia entotheiochroa* Hue. along with the existence of atranorin (depside) and a yellow pigment named entothein.2) As a continuation of the chemical investigation on the lichen substances, we have been engaged in the structural study of entothein and have reached a conclusion as shown in the present communication that entothein is identical with secalonic acid A3,4) (I), one of the major components of the ergot pigments. The finding revealed here seems to provide an insight of interest on the chemotaxonomical correlation between ergot and a fungus symbiotic in the above mentioned lichen.

Entothein (I) (isolated in 0.72% yield from the air dried lichen), $C_{32}H_{30}O_{14}$5) (mass spectrum *m/e*: 638 (M^+), 579 (base peak, M^+–$COOCH_3$)), mp 260° (yellow plates from $CHCl_3$–EtOH), $[\alpha]_D$ $-73°$ ($CHCl_3$), ultraviolet (UV) spectrum $\lambda_{\max}^{\mathrm{EtOH}}$ mμ (log ε): 266 (sh.) (4.28), 340 (4.58); $\lambda_{\max}^{\mathrm{EtOH\text{-}KOH}}$: 253 (4.42), 357 (4.55), infrared (IR) spectrum $\nu_{\max}^{\mathrm{KBr}}$ cm^{-1}: 3480 (br., hydroxyl), 1742, 1726 (m.), 1608 (carbonyls), 1588, 1560 (benzene ring), nuclear magnetic resonance (NMR) spectrum (DMSO–d_6) τ: 8.90 (6H, d.–like, $\rangle\mathrm{CHC\underline{H}_3}\times 2$), 7.9—7.2 (6H), 6.39 (6H, s., $-\mathrm{COOC\underline{H}_3}\times 2$), 6.4—6.0 (2H, $\rangle\mathrm{C\underline{H}OH}\times 2$), 4.05 (2H, d., $J=5$ cps, $\rangle\mathrm{CHO\underline{H}}\times 2$), 3.38, 2.55 (2H, each, ABq., $J=8$, aromatic *ortho* protons×2), -1.58 (2H, s., $\mathrm{O\underline{H}}\times 2$), exhibited red brown by $FeCl_3$, negative to Gibbs test and furnished a diacetate (II) (by *p*–toluenesulfonic acid and acetic anhydride treatment), $C_{32}H_{28}O_{12}(OCOCH_3)_2$, mp 245° (yellow plates from $CHCl_3$–MeOH), $[\alpha]_D$ $-130°$ ($CHCl_3$), positive (brown) to $FeCl_3$, UV $\lambda_{\max}^{\mathrm{EtOH}}$: 267 (4.26), 337.3 (4.60), IR (KBr): 1760 (acetyl) 1745 (ester), 1620 (chelated ketone), 1615, 1592, 1565 (benzene ring), NMR ($CDCl_3$): 8.97 (6H, d., $J=5$, $\rangle\mathrm{CHC\underline{H}_3}\times 2$), 7.86 (6H, s., $-\mathrm{OAc}\times 2$), 7.7—7.1 (6H), 6.32 (6H, s., $-\mathrm{COOC\underline{H}_3}\times 2$), 4.65 (2H, d., $J=11$, $\rangle\mathrm{C\underline{H}OAc}\times 2$), 3.52, 2.61 (2H, each, ABq., $J=8$, aromatic *ortho* protons×2), -1.53, -3.77 (2H each, s., $-\mathrm{O\underline{H}}\times 4$). On treatment with Ac_2O and NaOAc at reflux, entothein afforded an optically inactive acetate (=Y–Ac–E) (III), $C_{44}H_{38}O_{18}$, mp 208—209°, UV $\lambda_{\max}^{\mathrm{EtOH}}$:245.5 (4.96), 251 (5.01), 256.7 (5.01), 262 (4.87), 295 (4.11), IR (KBr): 1775 (acetyl), 1733, 1723 (ester), 1675 (conjugated ketone), 1610, 1595 (benzene ring), NMR ($CDCl_3$): 8.20, 8.09, 8.01 (6H each, all singlets totally six acetyls), 7.58 (6H, s, $=\overset{|}{\mathrm{C}}-\mathrm{C\underline{H}_3}\times 2$), 6.32 (6H, s, $-\mathrm{COOC\underline{H}_3}\times 2$), 2.94, 2.55 (2H each, ABq., $J=8$, aromatic *ortho* protons×2), 2.85, 2.45 (2H each, br.s., aromatic meta protons×2), while on thermal decomposition (at 280°, 3 Torr) it yielded a benzoate derivative, mp 91—92°, UV $\lambda_{\max}^{\mathrm{EtOH}}$: 245 (3.86), 304 (3.49), IR (KBr): 3420 (hydroxyl), 1697 (ester), 1618, 1597 (benzene ring), NMR ($CDCl_3$): 7.66 (3H, s., aromatic $\mathrm{C\underline{H}_3}$), 6.10 (3H, s., $-\mathrm{COOC\underline{H}_3}$), 3.97 (1H, s., $-\mathrm{O\underline{H}}$), 3.13 (1H, s.,), 2.61 (2H, br.s) (aromatic protons), mass: M^+ 166 (52.5%), 135 (base peak), 107 (44%), 77 (24.2%), whose physical properties are in good accord with methyl 3–hydroxy–5–methylbenzoate.3,4) Y–Ac–E, on treatment with either collidine or pyridine at reflux gave

---

1) I. Yosioka, M. Yamaki, and I. Kitagawa, *Chem. Pharm. Bull.* (Tokyo), **14**, 804 (1966).

2) Y. Asahina, "Lichens of Japan," Vol. II, Genus Parmelia, Res. Inst. for Natural Resources, Tokyo, 1952, p. 76.

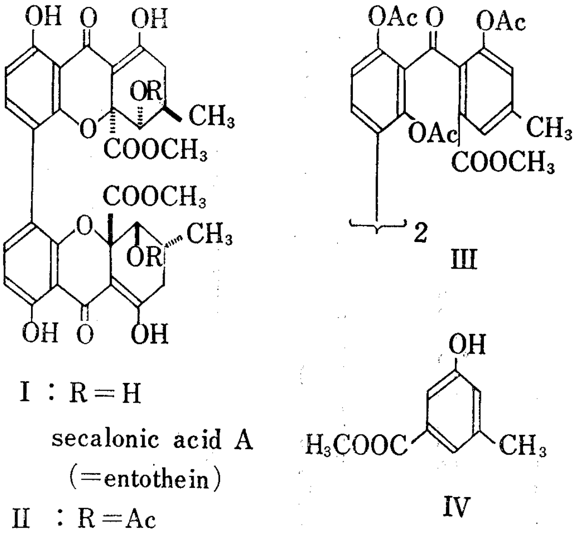
3) B. Franck, E.M. Gottschalk, U. Ohnsorge, and F. Hüper, *Chem. Ber.*, **99**, 3842 (1966).

4) J.W. ApSimon, J.A. Corran, N.G Creasey, W. Marlow, W.B. Whalley, and K.Y. Sim, *J. Chem. Soc.*, **1965**, 4144.

5) All the compounds given with the chemical formulae gave satisfactory analytical values. IR spectra were taken by the Hitachi EPI-G2 Grating Infrared Spectrometer and NMR spectra were measured at 100 Mc.

deep yellow grain crystals,[6] mp >300° ($FeCl_3$: green, conc. H_2SO_4: deep yellow with orange-green fluorescence), mass *m/e*: 566 (M^+), UV λ_{max}^{EtOH} 232 (4.52), 269.5 (4.60), 288.5 (sh) (4.52), 376 (4.04), IR (KBr): 1728 (ester), 1640 (conjugated ketone), 1610, 1580 (benzene ring).

The foregoing chemical and physical properties of entothein and its derivatives, in particular indicative of dimeric character based on their NMR spectra have led us to assume its identity with secalonic acid A or its related pigments[3] and furthermore to expect the identity of Y-Ac-E with a bis-benzophenone derivative (III) (previously described by Whalley, *et al.*[4] In fact, the direct comparisons (mixed mp, $[\alpha]_D$, IR, UV, TLC) of entothein with secalonic acid A performed kindly by prof. B. Franck and in this laboratory, and also of Y-Ac-E with III kindly done by Prof. W.B. Whalley have proved the correctness of the above assumption. Accordingly, the name of entothein hereafter must be replaced by secalonic acid A.



I : R=H

secalonic acid A (=entothein)

II : R=Ac

III

IV

Chart 1

As has been revealed[3] in case of ergot pigments, the present lichen also contains some other minor yellow coloring substances which are currently under study in this laboratory.

In addition, three related lichens, *P. perisidians* Nyl., *P. aurulenta* Tuck. and *P. subaurulenta* Nyl. have been found to contain secalonic acid A in respective yields of 0.36, 0.005 and 0.17%.

Acknowledgement We thank sincerely Professors B. Franck, Kiel University, Germany and W.B. Whalley, University of London, United Kingdom for their generous cooperation in making direct comparisons, to the Res. Lab. of Takeda Chem. Ind. and Dainippon Pharm. Co., Ltd. for measuring NMR spectra and elemental analyses, to Prof. Y. Inubushi, Kyoto University for mass spectra. We also thank Miss M. Yamaki, Mukogawa Women's University for taking part of the early stage of the investigation, and to Dr. S. Kurokawa, the National Science Museum, Tokyo for the identification of lichens.

Faculty of Pharmaceutical Sciences,
Osaka University,
Toyonaka, Osaka

Itiro Yosioka
Tsutomu Nakanishi
Satoko Izumi
Isao Kitagawa

Received July 11, 1968

---

[6] Although the compound exhibited single spot on TLC, as revealed by its NMR spectrum ($CDCl_3$): 7.60, 7.52, 7.50 (each singlet totally 6H, $=C-C\underline{H}_3\times 2$), 6.06, 6.04 (each singlet totally 6H, $-COOC\underline{H}_3\times 2$), 3.3—2.2 (8H, aromatic protons), -2.44, -2.66, -2.72 (each singlet totally 2H, $-O\underline{H}\times 2$), it appears to be a mixture of three bis-xanthone derivatives tentatively formulated as 1-hydroxy-6-methyl-8-carbomethoxy-xanthones dimeric at 2,2′; 2,4′ and 4,4′, whose further elucidation is in progress.