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Synthesis and Rearrangement of Quinone-Embedded Epoxycyclopentenones: A New Avenue to Pyranonaphthoquinones and Indenopyranones

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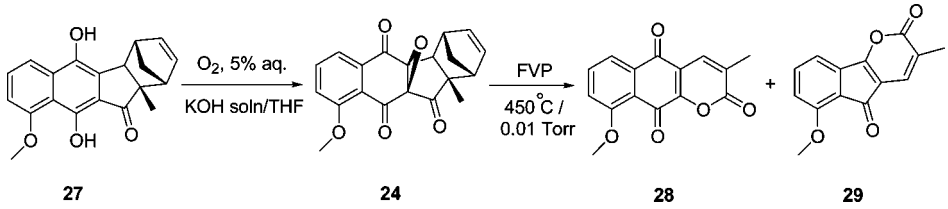

The epoxyquinones (e.g., **24**), readily assembled in one step from the quinols (e.g., **27**) by a simplified version of the Dowd oxidation, are shown to undergo rearrangement to pyranonaphthoquinones (e.g., **28**) and their ring contracted homologues (e.g., **29**) on flash vacuum pyrolysis at 450 °C and 0.01 Torr. The rearrangement has been demonstrated to be useful for a regiospecific synthesis of lambertellin (**3**). Similarly, the masked aziridinocyclopentanone **9** rearranges to 2-pyridone (**37**).

Introduction

The thermal rearrangement of epoxycyclopentenones to pyrones has been studied in detail from the mechanistic viewpoint.[1,2] It is established that an uncommon pericyclic reaction ($_4\pi_a + {}_2\pi_a$ process)[3] operates to form transient vinyl ketene intermediates, which in turn cyclize to 2-pyrones via a $_4\pi_s + {}_2\pi_s$ process. The reaction, however, has not received any attention from synthetic chemists.[4] The inaccessibility of the starting epoxides and the stringent reaction conditions have probably hindered the advancement of the reaction.[5] A few years ago, we utilized the rearrangement as a means for the synthesis of isocoumarins and benzoisocoumarins, and extended it to a regiospecific total synthesis of coriandrin, a furoisocoumarin natural product.[6] Our continued interest in the synthesis of quinonoids[7] prompted us to explore the possibility of extending the reaction to the synthesis of chemically sensitive pyranonaphthoquinone natural products, **1**−**5**[8,9] (Figure 1).

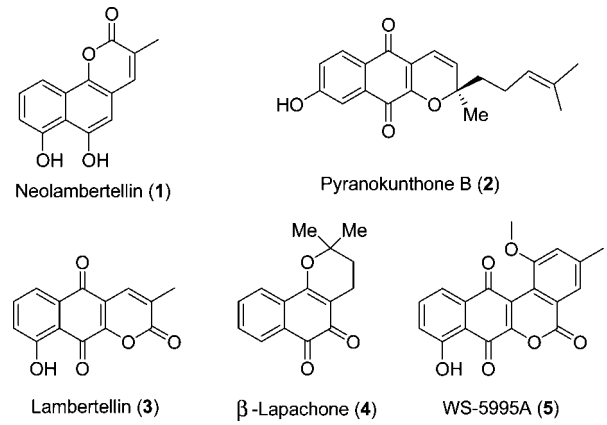

FIGURE 1. Representative structures of pyranonaphthoquinones.

The chemistry of pyrones, particularly fused ones, is of current interest and has recently been reviewed.[10] Naphtho-

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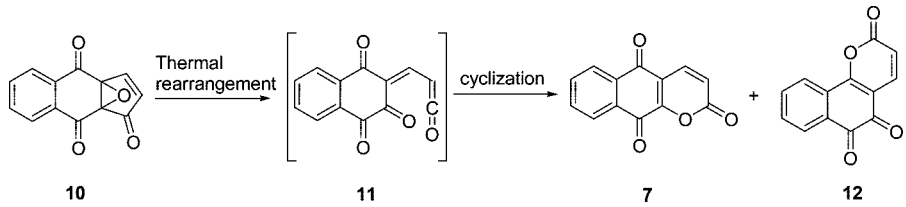
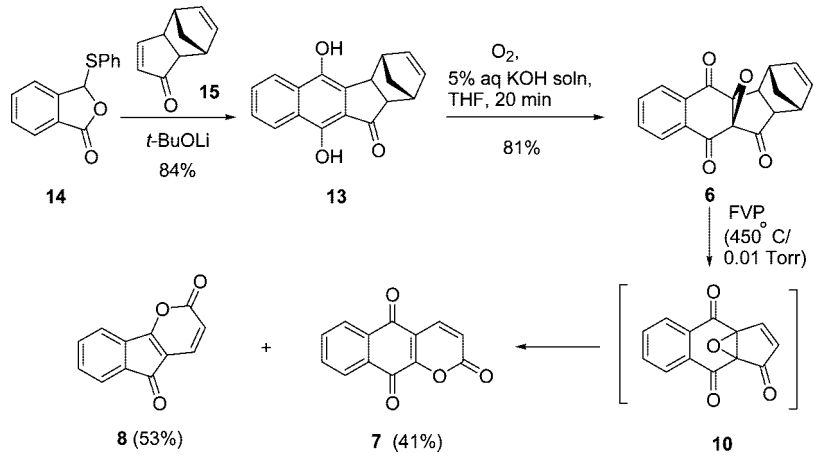
SCHEME 1. Proposed Thermal Rearrangement of Quinone-Embedded Epoxycyclopentenone



SCHEME 2. Rearrangement of Epoxide 6 to Naphthopyranone 7 and Indenopyranone 8



[2,3-*b*]pyranones represented by lambertellin (**3**) and β-lapachone (**4**) are an important subgroup of biologically active compounds.[11] They exhibit a wide variety of biological activities. For example, β-lapachone displays (i) anticancer[12] activity including efficacy in pancreatic cancer treatment, (ii) antimalarial[13] activity, (iii) anti-inflammatory[14] activity, and (iv) trypanocidal[15] activity. Lambertellin (**3**) is found to have antifungal activity and is implicated in mycoparasitism.[16] Herein, we report a de novo strategy for the synthesis of the quinone-embedded epoxycyclopentanones (e.g., **6**) in a single step from the respective quinols, and their rearrangement to naphtho-[2,3-*b*]pyranones (e.g., **7**) and ring-contracted analogues indeno-[1,2-*b*]pyranones (e.g., **8**). We also report that such a rearrangement is applicable to an aziridinocyclopentanone (e.g., **9**).

Results and Discussion

The synthetic strategy conceived is outlined in Scheme 1. The rearrangement of epoxide **10** was envisaged to form unstable vinyl ketene **11**, which, in turn, would form both 1,4-naphthoquinone **7** and 1,2-naphthoquinone **12**, according to the established mechanistic pathways. However, on the basis of the energy minimization of the two structures at the B3LYP/6-31G (d) level and the reversibility of a pericyclic reaction, it was further predicted that isomer **7**, more stable by 2.9 kcal/mol than **12**, would exclusively be formed, and thus the rearrangement would serve as a novel route to the lambertellins (e.g., **3**).

Since the preparation of the precursor epoxide **10**, unknown in the literature, proved to be a difficult task,[17] we undertook the preparation of its precursor **6** from the corresponding quinol **13** (Scheme 2),[18] anticipating that compound **6** would form epoxide **10** via retro-Diels−Alder reaction. Accordingly, the key quinol **13** was prepared in one step according to the literature precedent[18] from phthalide **14** with tricyclic enone **15**. For the conversion of the quinol **13** to the epoxide **6**, Dowd oxidation,[19] a direct oxidation of a hydroquinone to its quinone oxide, was examined. The mechanism of this reaction is well elucidated in connection with the delineation of the mechanism of Vitamin K action. However, it has not found any preparative use in synthetic organic chemistry. Exposure of the quinol **13** to the nonenzymatic conditions[19] developed by Ham and Yoo, i.e., treatment with KH followed by bubbling of oxygen, provided

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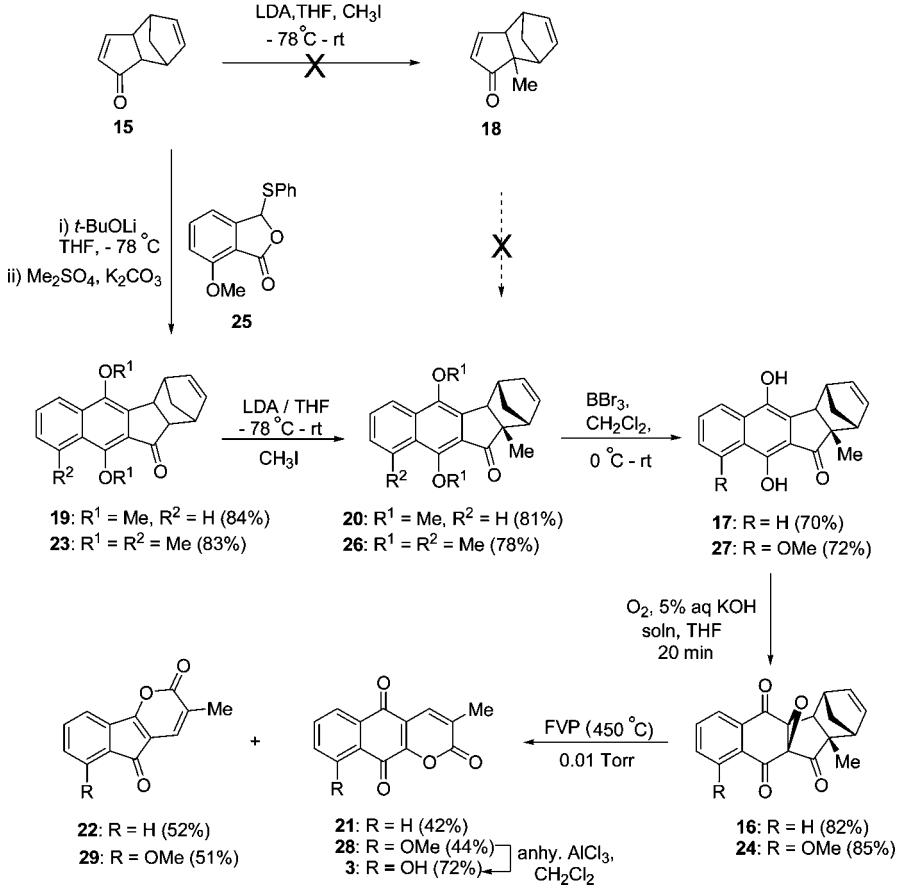
SCHEME 3. Synthesis and Rearrangement of the Epoxides 16 and 24



the desired epoxide **6** in one step but in low yield (<30%). After extensive experimentation, we met the optimal conditions: O_2, 5% aq KOH in THF at rt under which the quinol **13** underwent smooth transformation to the epoxide **6** in 81% yield. It was readily purified by silica gel chromatography. For the proposed retro-Diels−Alder reaction, the hexacyclic quinone **6** was heated in refluxing diphenyl ether as well as *o*-dichlorobenzene. In both cases, extensive decomposition of the epoxyquinone took place. No tractable product was isolated. When the epoxide **6** was subjected to flash vacuum pyrolysis (FVP) at 450 °C/0.01 Torr, two products, **7** (41%) and **8** (53%) (Scheme 2), were identified. These structures were determined on the basis of spectroscopic evidence. Structure **12** was ruled out as the structure of the product after completion of the total synthesis of lambertellin (**3**) described below. Although the formation of the pyranonaphthoquinone **7** was in accordance with the proposed formation of epoxide **10** and its ring-opening followed by recyclization, the other expected structure **12** was not formed. On the contrary, the intriguing formation of indenopyranone **8** was noted. All the spectroscopic data including mass spectral data were consistent with the proposed structure. On the basis of the NMR data as discussed later, two alternative structures for **8**, i.e., naphtho[1,2-*b*]furan-4,5-dione[20] and naphtho[2,3-*b*]furan-4,9-dione,[21] were ruled out. The support for structure **7** was derived from the analysis of Dauson et al. applied to α-lapachone and *β*-lapachone.[22]

For establishing the generality of the rearrangement and determining the structure of the unusual ring-contracted product **8**, we examined the reactivity of a few substituted analogues of the epoxide **6**. As a second example, we chose to extend the methodology to annularly substituted epoxyquinone **16** (Scheme 3), which was expected to provide a deoxy analogue of lambertellin (**3**). The synthesis of the quinone, when patterned after the synthesis of hexacyclic epoxide **6**, called for the synthesis of precursor quinol **17** and the corresponding tricyclic enone **18**. Although the preparation of the enone **18** seemed trivial, it proved more problematic in practice than we had hoped. Attempted *C*-methylation of enone **15** by LDA−CH_3I, NaH−CH_3I, etc. resulted in the formation of an inseparable mixture of products, which probably arose from thermal isomerization[23] of the initial methylated product. In an alternative route, the pentacyclic quinol ether **19**[18] was utilized for access to the epoxyquinone **16**. Reaction of dimethyl ether **19** with methyl iodide in the presence of LDA at − 78 °C produced methyl-substituted product **20** in 81% yield. *O*-Demethylation of compound **20** with BBr_3 (20 equiv) in dichloromethane at 0 °C produced quinol **17** in 70% yield. Treatment of the quinol with oxygen in the presence of 5% aq KOH solution in THF yielded epoxide **16** (82%). FVP of the epoxide **16** at 450 °C/0.01 Torr followed by chromatography of the pyrolysate yielded two products: **21** (42%) and **22** (52%). Their structures were assigned on the basis of spectroscopic data.

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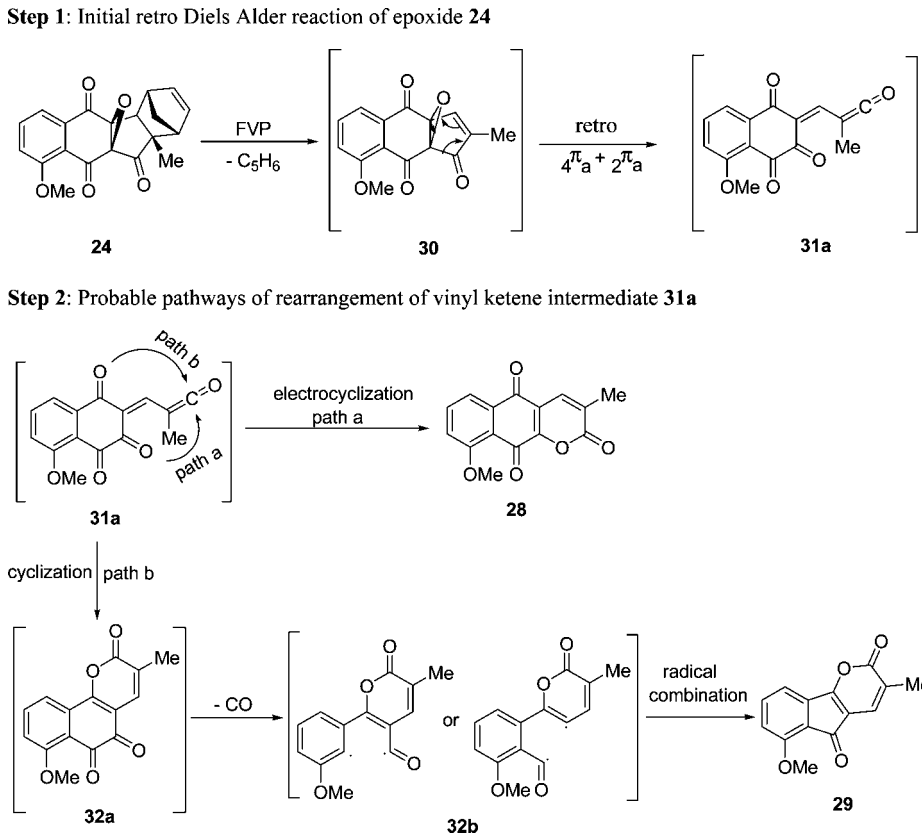
SCHEME 4. Probable Mechanism for the Formation of 28 and 29 from 24[a]



[a] Step 1: Initial retro-Diels−Alder reaction of epoxide **24**. Step 2: Probable pathways of rearrangement of vinyl ketene intermediate **31a**.

In a similar fashion as for **16**, trimethoxy quinol ether **23** was elaborated to epoxyquinone **24**. Compound **23**[24a] was prepared by the Hauser annulation[24b,c] of enone **15** with phthalide **25**, followed by *O*-dimethylation of the resulting quinol with $Me_2SO_4-K_2CO_3$ in overall 83% yield. It was then submitted to the sequence of *C*-methylation, *O*-demethylation, and Dowd oxidation. *C*-Methylation of 9-methoxy derivative **23** with CH_3I produced compound **26** in 78% yield. Demethylation of **26** with BBr_3 in dichloromethane at 0 °C selectively generated quinol **27** in 72% yield. An attempted perdemethylation with excess BBr_3 resulted in a complex mixture rather than the desired hydroxyquinol. Treatment of the quinol **27** with oxygen in the presence of 5% aq KOH solution in THF yielded epoxide **24** in 85% yield. The spectral data and the X-ray crystallographic data were consistent with the structure. FVP of the epoxide at 450 °C/0.01 Torr pressure yielded the rearrangement products **28** (44%) and **29** (51%). *O*-Methyllambertellin (**28**), on treatment with anhydrous $AlCl_3$ in dichloromethane, yielded lambertellin (**3**) (72%) (Scheme 3). To our delight, both ^1H and ^{13}C NMR spectra of the synthetic sample agreed well with the reported data.[16]

The rearrangement of **24** to **28** and **29** is rationalized on the basis of the earlier understanding of the thermal rearrangement[1] of the simple epoxycyclopentenones and a probable mechanism has been presented in Scheme 4. The cascade reaction is initiated by thermally allowed extrusion of cyclopentadiene forming epoxycyclopentenone **30**. Since the epoxy intermediate **30** has requisite structural features for retro [$_4\pi_a + {}_2\pi_a$] reaction, it undergoes the ring-opening to form vinyl ketene trione **31a**. The vinyl ketene intermediate **31a** may then cyclize via paths "a" and "b" to form pyranonaphthoquinones **28** and **32a**, respectively. The intermediate **32a**, on decarbonylation followed by radical combination, might lead to the formation of **29**. It may be noted that the thermal decarbonylation of quinones or ketones, although uncommon, is reported to take place at high temperature (1100−1180 °C).[25] Determination of the structure of **28** was supported by the fact that with anhydrous $AlCl_3$, it underwent *O*-demethylation to give lambertellin (**3**). The spectroscopic data of the synthetic sample perfectly matched with the reported values.[16] The structure of the pyranonaphthoquinone **28** was also confirmed by its HMBC and HSQC data (Table 1). The possibility of the formation of **29** from **28** was ruled out by a model experiment on structurally analogous quinone **7**. The attempted conversion of quinone **7** to **8** by FVP under the conditions of its formation from **6** returned the starting material (e.g., **7**).

The alternative pathways for the formation of the ring contracted product **29** as well as other possible isomeric products are outlined in Scheme 5. The loss[25] of carbonyl "a" from the intermediate **31a** followed by radical combination[26] and subsequent 6π electrocyclization would produce structure **31c**. Decarbonylation of ketene carbonyl[27] "b" from the intermediate

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TABLE 1. Summary of Key Information from HMBC Experiment for Compounds 22, 28, and 29

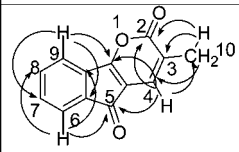
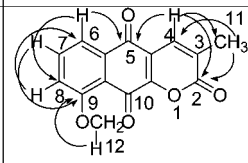
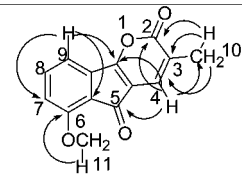
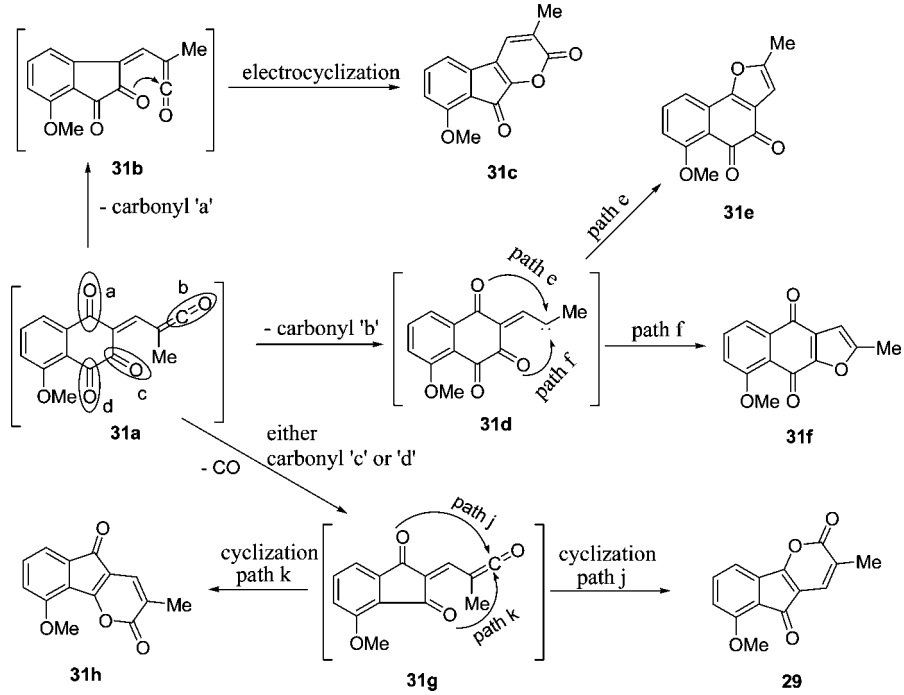
	Compound **22**	Compound **28**	Compound **29**
HMBC			

TABLE 2. Comparison of ^{1}H and ^{13}C NMR Data of Compounds 22, 29, and 34

	compd **22**[a]		compd **29**[b]		compd **34**[c]	
position	δ_H (*J*/Hz)	δ_C	δ_H (*J*/Hz)	δ_C	δ_H (*J*/Hz)	δ_C
2		161.8		162.0		161.6
3		122.6		122.8		122.3
4	7.51−7.40 m	133.3	7.52−7.44 m	133.5	7.64−7.43 m	133.0
4a		111.2		111.3		111.5
5		187.8		186.3		188.3
5a		132.6		116.7		132.5
6	7.58 d (6.8)	123.5		157.1	7.64−7.43 m	124.2
7	7.51−7.40 m	119.9	7.02 d (8.6)	117.2	7.64−7.43 m	121.1
8	7.51−7.40 m	133.8	7.52−7.44 m	136.1	7.64−7.43 m	134.4
9	7.51−7.40 m	131.9	7.04 dd (7.2, 0.6)	112.9	7.64−7.43 m	129.2
9a		136.0		137.9		136.2
9b		174.1		171.8		172.4
10	2.17 s	17.6	2.17 s	17.6		
11			4.0 s	56.1		

[a] Recorded at 400 MHz (^{1}H) and 100 MHz (^{13}C) in $CDCl_3$. [b] Recorded at 200 MHz (^{1}H) and 100 MHz (^{13}C) in $CDCl_3$. [c] Recorded at 300 MHz (^{1}H) and 75.5 MHz (^{13}C) in d_6-DMSO (ref 29).

SCHEME 5. Other Possibilities of Cyclization and Decarbonylation of Vinyl Ketene Intermediate 31a



31a should produce vinyl carbene **31d** which, in turn, may cyclize in two possible ways to produce **31e** and **31f**. But both structures were discarded on consideration of the upfield chemical shifts of furan hydrogens of the reported furanonaphthoquinones.[28] The probable loss of either carbonyl "c" or "d" from **31a** may lead to formation of **29** and **31h**. However, the spectroscopic data (^{1}H, ^{13}C, and HMBC) of the product suggested that compound **29** was formed. The structures **31c** and **31h**, isomeric with **29**, were discarded due to mismatch in HMBC data. In the HMBC spectra of **8**, **22**, and **29**, there are three bond couplings between the C-4 vinyl protons and the carbonyl groups, which do not corroborate with the structures

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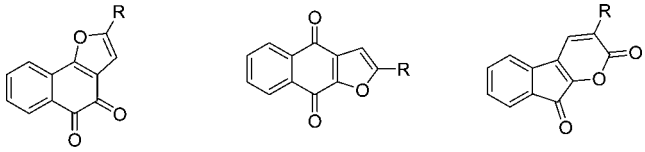
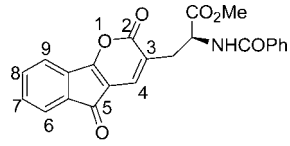


33a: R = H
33b: R = Me
33c: R = H
33d: R = Me
33e: R = H
33f: R = Me

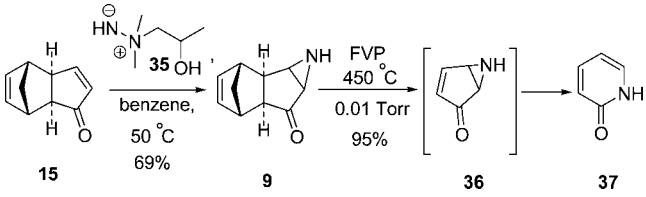
FIGURE 2. Other probable structures of compounds **8** and **22**.



34

FIGURE 3. Structure of (*S*)-*N*-benzoyl-3-(2,5-dioxo-2*H*,5*H*-indeno[1,2-*b*]pyranyl-3)alanine methyl ester.

SCHEME 6. Synthesis and Rearrangement of Aziridinocyclopentanone 9



15 **9** **36** **37**

31c, **33e**, and **33f**. The structures of **8**, **22**, and **29** were also in agreement with the HMBC and HSQC data.

The alternative furanoquinone structures **33a**, **33b**, **33c**, and **33d** (Figure 2) for both **8** and **22** were ruled out on the basis of the chemical shifts of the vinyl protons.[28] Further, the structures of indenopyranones **22** and **29** were supported from the comparison of its spectroscopic data (Table 2) with those of **34** (Figure 3).[29]

Next, we considered extension of the rearrangement to an aziridinocyclopentanone system. Accordingly, we aimed at preparing an aziridine by elaboration of enone **15**. After several unsuccessful attempts,[30] we succeeded with the method[31] of Ikdea et al. involving the reaction of aminimides. Treatment of tricyclic enone **15** with aminimide **35** prepared in situ from *N*,*N*-dimethylhydrazine and propylene oxide in 2-propanol at 50 °C furnished aziridinocyclopentanone **9** in 69% yield (Scheme 6). As expected, FVP of the tetracyclic aziridine **9** under the same condition provided 2-pyridone[32] (**37**) in 95% yield constituting the first example of the aza-version of the rearrangement. Methylation of compound **37** with CH_3I in the presence of K_2CO_3 furnished *N*-methyl-2-pyridone in 85% yield as a yellow oil, the spectral data of which matched well with the reported values.[33]

Conclusion

In conclusion, this study demonstrates that the thermal rearrangement of the quinone-embedded epoxycyclopentenones leads to the formation of naphtho[2,3-*b*]pyranones, indeno-[1,2-*b*]pyranones, and pyridone ring systems. It also demonstrates that the polycyclic epoxy precursors can readily be prepared by combined application of the Hauser annulation and the Dowd oxidation. From the synthetic perspective, the developed methodology has been employed in a total synthesis of lambertellin (**3**). Development of an alternative to the FVP technique as well as an independent synthesis of the indeno-[1,2-*b*]pyranones for the reconfirmation of the structures **8**, **22**, and **29** is underway.

Experimental Section

General Procedure for Flash Vacuum Pyrolysis. A long (40 cm) high-quality glass tube open at both ends was fixed horizontally in a pyrolytic chamber connected in series with a rheostat and an ammeter. One end of the glass tube was closed, and a vial containing the substance to be pyrolyzed was pushed inside until it was adjacent to the heating coil. The open end was covered with cotton plug and then connected to a high-vacuum pump. The material in the vial was heated with a burner until it melted, then was pushed inside the furnace after it reached 450−500 °C (monitored by a thermocouple). Heating was continued until all the material was collected in the cold zone of the glass tube and the rest was collected in a liquid N_2 trap. After the tube was cooled to the ambient conditions, the pyrolysate was dissolved in dichloromethane. Finally, it was purified by column chromatography.

4b,10a-Epoxy-1,4,4a,4b,10a,11a-hexahydro-1,4-methano-11*H*-benzo[*b*]fluoren-5,10,11-trione (6). To a solution of quinol **13** (450 mg, 16.2 mmol) in THF (20 mL) was added a solution of KOH (45 mg, 0.81 mmol in 5 mL of water). Oxygen was bubbled through the resulting deep reddish solution for about 20 min, at which time the color changed to green and finally pale yellow. The reaction mixture was extracted with ethyl acetate (3 × 50 mL). The combined extracts were washed with H_2O (2 × 30 mL) and brine (30 mL), dried (anhydrous Na_2SO_4), and concentrated. The resulting residue was purified by column chromatography on silica gel to get pure product **6** (384 mg) as a white solid. Yield 81%; R_f 0.45 (1:3 ethyl acetate/petroleum ether); mp 167−168 °C; ^{1}H NMR (200 MHz, $CDCl_3$) δ 8.04−7.94 (m, 2H), 7.81−7.71 (m, 2H), 6.12 (dd, 1H, J = 2.8, 5.5 Hz), 5.89 (dd, 1H, J = 2.8, 5.6 Hz), 3.69−3.65 (m, 1H), 3.45−3.35 (m, 2H), 3.07−3.01 (m, 1H), 1.74−1.54 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 200.5, 188.9, 186.7, 135.7, 134.9, 134.6, 134.1, 132.7, 131.6, 127.3, 127.2, 72.0, 62.2, 51.6, 50.9, 46.5, 44.1, 40.8; ν_{max} (KBr, cm^{-1}) 1757, 1690, 1590, 1298, 1168, 913, 717; HRMS (ES) calcd for $C_{18}H_{12}O_4$ (MH^+) 292.0736, found 292.0741.

2*H*-Naphtho[2,3-*b*]pyran-2,5,10-trione (7). This compound was prepared as a yellowish solid in 41% yield by flash vacuum pyrolysis of **6** according to the described procedure. R_f 0.5 (1:1 ethyl acetate/petroleum ether); mp 217−219 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.26−8.21 (m, 2H), 8.1 (d, 1H, J = 9.6 Hz), 7.87−7.83 (m, 2H), 6.71 (d, 1H, J = 9.6 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 180.3, 175.8, 157.5, 154.2, 138.2, 135.0, 134.7, 131.2, 130.9, 127.3, 127.0, 121.4, 118.7; ν_{max} (KBr, cm^{-1}) 1752, 1678, 1620, 1420, 1312, 970; HRMS (ES) calcd for $C_{13}H_7O_4$ (MH^+) 227.0345, found 227.0343.

2*H*-Indeno[1,2-*b*]pyran-2,5-dione (8). This compound was prepared as a reddish yellow solid in 53% yield by flash vacuum pyrolysis of **6** according to the described procedure. R_f 0.7 (1:1 ethyl acetate/petroleum ether); mp 179−180 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64−7.60 (m, 2H), 7.56−7.47 (m, 3H), 6.21 (d, 1H, J = 9.2 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 187.3, 176.8, 160.0, 137.5, 135.7, 134.0, 133.0, 132.6, 123.7, 120.5, 112.0, 110.8; ν_{max} (KBr, cm^{-1}) 1744, 1710, 1546, 1394, 1078; HRMS (ES) calcd for $C_{12}H_7O_3$ (MH^+) 199.0396, found 199.0416.

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4b,10a-Epoxy-1,4,4a,4b,10a,11a-hexahydro-1,4-methano-9-methoxy-11a-methyl-11*H*-benzo[*b*]fluoren-5,10,11-trione (24). This compound was prepared as a white solid from **27**, according to the same procedure for the preparation of compound **6**. Yield 85%; R_f 0.58 (1:5 ethyl acetate/petroleum ether); mp 176−177 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (t, 1H, J = 8 Hz), 7.55 (d, 1H, J = 7.6 Hz), 7.27 (d, 1H, J = 8 Hz), 6.15 (dd, 1H, J = 2.8, 5.6 Hz), 5.87 (dd, 1H, J = 2.8, 5.6 Hz), 3.91 (s, 3H), 3.62 (br s, 1H), 2.92 (d, 1H, J = 4 Hz), 2.87 (br s, 1H), 1.77 (ABd, 1H, J = 8.8 Hz), 1.71 (ABd, 1H, J = 8.8 Hz), 1.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 202.7, 189.9, 186.0, 159.2, 136.4, 134.9, 134.1, 133.8, 121.1, 119.3, 118.4, 71.7, 62.9, 57.1, 56.4, 52.6, 49.8, 47.9, 44.9, 23.1; ν_{max} (KBr, cm^{-1}) 2973, 1757, 1698, 1649, 1280, 1066, 950, 755; HRMS (ES) calcd for $C_{20}H_{17}O_5$ (MH^+) 337.1077, found 337.1080.

9-Methoxy-3-methyl-2*H*-naphtho[2,3-*b*]pyran-2,5,10-trione (28). This compound was prepared as a yellowish solid in 44% yield by flash vacuum pyrolysis of **24** according to the described procedure. R_f 0.45 (1:5 ethyl acetate/petroleum ether); mp 228−229 °C; ^{1}H NMR (200 MHz, $CDCl_3$) δ 7.84−7.71 (m, 3H), 7.37 (dd, 1H, J = 1.2, 8.2 Hz), 4.05 (s, 3H), 2.28 (d, 3H, J = 1.4 Hz); ^{13}C NMR (100 MHz, $CDCl_3$) δ 180.9, 174.3, 160.7, 159.9, 152.9, 135.9, 133.4, 132.2, 131.8, 119.6, 118.6, 117.7, 116.4, 56.7, 17.6; ν_{max} (KBr, cm^{-1}) 1743, 1676, 1388, 1299, 1197, 974, 722; HRMS (ES) calcd for $C_{15}H_{10}O_5$ (MH^+) 271.0607, found 271.0596.

9-Hydroxy-3-methyl-2*H*-naphtho[2,3-*b*]pyran-2,5,10-trione (Lambertellin) (3). To a stirred solution of **28** (0.02 g, 0.07 mmol) in dry dichloromethane at 0 °C under N_2 atmosphere was added anhydrous aluminum chloride (0.03 g, 0.22 mmol) and the solution was stirred at rt for 4 h. The reaction was quenched by addition of 15% HCl (1 mL), extracted with dichloromethane (2 × 30 mL). The extracts were worked up in the usual manner. Yield 72%; R_f 0.4 (1:1 ethyl acetate/petroleum ether); mp 250−251 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.79 (s, 1H), 7.85 (s, 1H), 7.76−7.68 (m, 2H), 7.34 (d, 1H, J = 4.2 Hz), 2.31 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 180.5, 179.9, 162.3, 159.2, 152.4, 137.4, 133.4, 133.1, 130.9, 125.3, 120.0, 119.9, 114.4, 17.7; ν_{max} (KBr, cm^{-1}) 2930, 1748, 1642, 1576, 1282, 1058; HRMS (ES) calcd for $C_{14}H_8O_5$ (MH^+) 257.0451, found 257.0455.

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Supporting Information Available: General experimental methods; experimental procedures and characterization data of compounds **9**, **16**, **17**, **20**, **21**, **22**, **26**, **27**, **29**, and **37**; ^{1}H, ^{13}C, and DEPT-135 NMR copies of compounds **3**, **6**, **7**, **8**, **16**, **17**, **20**, **21**, **22**, **24**, **26**, **28**, and **29**; ^{1}H and ^{13}C NMR copies of **9**, **27**, and **37**; HMBC and HSQC for compounds **8**, **22**, **28**, and **29**; COSY of compound **8**; and an ORTEP diagram of epoxide **24**. This material is available free of charge via the Internet at http://pubs.acs.org.

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