

FURTHER RESEARCHES ON THE FUROCLERODANES FROM *TEUCRIUM* SPECIES

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Abstract - The review updates the advances reported during the last six years on the chemistry of these diterpenoids.

Highlights on the chemistry of the furanoditerpenoids with *neo*-clerodane skeleton isolated from species of the genus *Teucrium* (family Labiatae) were reported in the last decade.^{1,2} Recently, a general review³ on the *neo*-clerodane diterpenoids reported briefly also on the products from *Teucrium*, but the references stop at 1990. The remarkable increase of the number of new natural derivatives and several peculiarities of their structures prompt to update the previous review.²

The genus *Teucrium*, with its 300-400 species (and more subspecies, varieties and chemotypes), is up to now the richest natural source of *neo*-clerodane diterpenoids. Up today (July 1993) the products isolated and characterized are as many as 154, while in the first review¹ only 35 derivatives were reported, and their number had increased to 103 in the second review.² This demonstrates the rich biological differentiation of the species within the genus. Moreover, the occurrence of these products only inside this genus makes them authentic chemotaxonomic markers.

Dedicated to Prof. Alan R. Katritzky in the occasion of his 65th birthday.

Beyond our staff, other research groups are active in the chemistry of *Teucrium* diterpenoids: in Bulgaria, Chile, Spain and Popular Republic of China. The interest is stimulated by the structural challenge and by the insect antifeedant activity of these products.⁴ On the purpose of clearness in the exposition of the results, we decided to keep and continue the numbering used in the previous review,² the last number used being [103] for teuflavoside.

This review starts correcting some minor misprints of the previous review.² So in structures [35] and [36] the axial 9α -CH₃ was missing. In the structure [49] of picropolinol, the hydroxy groups at C-18 and C-19 are acetylated, and the formula is C₂₄H₃₀O₁₀. Montanin C [8] is the 12-epimer of 6-acetylteucjaponin B [20] and not of teucjaponin B [19]. The reference for teuscorodin [85] is 38 and not 39.

The controversy about the configuration at C-12 of teupolin I was settled. The product isolated from *T. polium*⁵ and named teupolin I was confirmed by the same authors⁶ to have the 12*S* configuration on the basis of careful nOe studies. The product isolated from *T. scorodonia*⁷ and *T. lanigerum*⁸ and believed, on the basis of physical data (mp, $[\alpha]_D$, nmr), to be identical with teupolin I, is different as the configuration at C-12 is really 12*R* as suggested previously.⁷ Therefore the product indicated as "teupolin I" in our previous review² is 12-*epi*-teupolin I (synonymous, 12*R*-teupolin I) and does have structure [9]. The true teupolin I is therefore represented by [104].

The structure of teupolin IV, given⁹ as [11], was amended by the same authors⁶: the primary hydroxy group on C-19 is acetylated, and not the secondary one on C-7. So in the structure [11] the groups have to be indicated as 5α -CH₂OAc and 7β -OH. Accordingly, the product reported² as "19-acetylteupolin IV" must be named 7-acetylteupolin IV, the structure [12] being correct.

The most interesting developments in the chemistry of these furanoditerpenoids are concerned mainly with the occurrence of oxygen functions on unusual positions. We can remark that until 1991 the only derivative with 8β -OH was the already reported² 8β -hydroxyfruticolone [39]. In that year, teupernin B [105] and teupernin C [106] were isolated by Chinese researchers¹⁰ from *T. pernyi*, both products having the 8β -OH

functionalization. Teupernin B was isolated¹¹ also from *T. bidentatum* (growing in China) and named bidentatin.

No derivative was known with oxygen function on C-10 until we isolated¹² teupestalin A [107] and teupestalin B [108] from *T. pestalozzae* collected in Turkey. The first product has a 10 β -OH group, whereas the second one shows a β -oriented hemiacetalic bridge between C-10 and C-3. Other *neo*-clerodanes with unusual features at C-10 occurred¹³ in *T. oliverianum* (from Saudi Arabia): teucrolivin A [109] has a β -oriented hemiacetalic system connecting C-10 and C-12; teucrolivin B [110] and teucrolivin C [111] have a 10 β -OH substituent. Teucrolivin F is¹⁴ a tetra-*nor-neo*-clerodane [112], the first found in *Teucrium* genus: it missed the furan system and formed a γ -lactone ring between C-12 and C-10. Still more interesting are teucrolivin H and its acetyl derivative teucrolivin G: their structures were elucidated¹⁵ as [113] and [114] respectively. They show a quite unprecedented (in nature) 2,6-dioxabicyclo[2.2.1]heptane system arising from the acetalization of C-12 with two hydroxy groups on C-8 and C-10, both β -oriented. These unusual structures were confirmed by X-ray diffraction analysis.

New, but not unusual, derivatives were isolated from the above species. So *T. pernyi* gave¹⁰ teupernin A [115], *T. pestalozzae* yielded¹⁶ 4 α ,18-epoxytafricanin A [116] and 20-oxo-teuflavin [117], *T. oliverianum* contained¹⁴ teucrolivin D [118] and teucrolivin E [119].

Chinese researchers¹⁷ isolated teuponin [120] from *T. japonicum*. This *nor-neo*-clerodane is remarkable because the furan ring is transformed into a 15*R*-hydroxy-13,14-en-16,15-olide system, whereas the remaining structure is identical with teuflin [93].

The 12-epimer of teuscorodonin was isolated¹⁸ from *T. bicolor*, growing in Chile, and its rare 12*R* configuration ascertained by nOe experiments. So 12-*epi*-teuscorodonin has structure [121]. By the same way, these authors¹⁸ confirmed the 12*S* configuration proposed, but not proved, for teucrin H2 [76] (synonymous, teuchamaedryn B).

A novel product arose from a reinvestigation of *T. fruticans* (collected in Sicily). Fruticolide, an isomer of fruticolone [38], is a minor component and was shown¹⁹ to have the 5,6-*seco* structure [122] with an ϵ -lactone ring joining C-6 to C-1: structure and stereochemistry were confirmed also by X-ray diffraction. This is the first case of a *seco* derivative in *Teucrium* genus.

The investigation of *T. gracile*, from the island of Karpathos (Greece) gave six new diterpenoids. Teugracilin A [123] is a typical representative of the group having the 4,18-epoxy system and the 20,12- γ -lactone;²⁰ 3-O-deacetylteugracilin A [124] and teugracilin B [125] are²⁰ a couple of epimers at C-6, having 6 β -OH and 6 α -OH respectively. Teugracilin C [126] lacks²⁰ the γ -lactone ring: an OAc group occurs at C-12, whose configuration was not ascertained. Teugracilin D [127] shows¹⁹ a 20-O-acetylated lactol ring, whereas teugracilin E [128] has¹⁹ carbon C-20 in the rare form of CH₂OAc and a secondary OAc group at C-12, whose configuration is unknown.

Two new *neo*-clerodanes were isolated²¹ from the Spanish species *T. oxylepis* subsp. *marianum*. Teucroxylepin [129] shows the δ -lactone ring from C-20 to C-19, and a 12R hydroxy group at C-12. The second product is the 12-acetyl derivative [130] of teugnaphalodin [69].

Extraction of *T. lamiifolium*, collected in Bulgaria, gave²² the new 12-*epi*-teupolin II [131] having the infrequent 12R configuration. Another product, "teulamifin B", was isolated and proved²³ to have a secondary hydroxy group in 12S configuration: apart this stereochemistry, "teulamifin B" was identical with the already known teubotrin²⁴ [61] whose C-12 configuration was not proved at that time. In spite of discrepancies in mp and ¹³C nmr data, the two products were finally found²⁵ to be identical and represented as [61] with 12S stereochemistry.

T. abutiloides, from the island of Madeira (Portugal), contained²⁶ two new *neo*-clerodanes, teubutilin A [132] and teubutilin B [133]. The absolute configuration of the former was confirmed by correlation with teucrin P1 [24], whereas the absolute configuration of the latter was not proved: however it is believed to belong to the *neo*-clerodane series like teubutilin A.

Two new diterpenoids were isolated by the Bulgarian group. *T. montanum* subsp. *skorpilii* contained montanin G: it is represented²⁷ by structure [134], therefore is the 3-O-deacetyl derivative of teupyrein [28], with which it was easily correlated. The occurrence of the unusual 12R configuration is worthy of remark. *T. montanum* subsp. *montanum* yielded²⁸ montanin H [135]: neither the C-12 stereochemistry nor the absolute configuration were ascertained, but it may be supposed to belong to the *neo*-clerodane series.

A reinvestigation of *T. massiliense*, collected in Sardinia, led to the isolation²⁹ of a new minor constituent, teumassin [136]: its structure was confirmed by correlation with a known derivative of teumarin [34], whose absolute stereochemistry was established previously.

A group of species growing in the East Mediterranean area gave many new and interesting products. So a derivative of chamaedroxide [88] was found³⁰ in *T. divaricatum* subsp. *canescens* from the island of Cyprus: it is 2-deoxychamaedroxide [137], with the unusual oxetane ring connecting C-4, C-5 and C-6.

Teucretol [138] was isolated³¹ from *T. creticum*, collected in the island of Cyprus. It is the first example of C-20 as a CH₂OH group: the only other case of such oxygenation is represented by teugracilin E [128], having however C-20 as a CH₂OAc substituent.

T. micropodioides, again from Cyprus, yielded five new derivatives.³² Teumicropin [139] and 3-acetylteumicropin [140] were transformed into teupyrenone [32], thus firmly establishing their structures and absolute configuration. A third product, 3-O-deacetyl-teupyrenone [141] was also easily correlated with teupyrenone. Teumicropodin [142] was correlated with a synthetic derivative of teulepicin [44], whose absolute stereochemistry was known. The last product, 3-O-deacetyl-20-*epi*-teulanigin [143], was easily correlated with 20-*epi*-teulanigin [42]. So the absolute configuration of all five *neo*-clerodanes from *T. micropodioides* was ascertained.

An interesting product, isoteucrin H4, was extracted³³ from *T. kotschyannum*, always from the island of Cyprus. Its structure [144] is the first example of a 19-*nor-neo*-clerodane derivative isolated from a natural source having a C-5, C-10 double bond. Its occurrence supports previous hypotheses on the biogenesis of the 19-*nor-neo*-clerodanes belonging to the 10 α -series, like teucvidin [91] and teuflidin [95]. The structure [144] was confirmed by isomerisation of the acetate of teucrin H4 [94] into the acetate of isoteucrin H4.

Three more new diterpenoids were extracted³⁴ from *T. kotschyannum*. The first and second products are 12-*epi*-teucvidin [145] and 12-*epi*-teuflin [146], both having the infrequent 12R configuration. The third product, teukotschyn [147], has a C-18,C-19 hemiacetalic ring.

A second example of a 19-*nor* derivative of biogenetic interest with C-5, C-10 double bond was found³⁵ in *T. canadense*. The product is isoteuflin [148], previously known only as a synthetic derivative obtained by base catalysed isomerization of teuflin [93]. In our hands,

mild basic treatment of both teuflin and isoteuflin gave the same mixture of isoteuflin and teucvidin [91].

A second new product was also isolated³⁵ from *T. canadense*, 18-acetylmontanin D [149], having like the parent compound [46] the oxetane ring connecting C-4, C-5, C-19.

Three interesting structures were given³⁶ to products occurring in the Portuguese species *T. polium* subsp. *vincentinum*. Teuvincentin A [150] contains a chlorine atom on C-18, clearly arising from the opening of the 4 α ,18-oxirane ring. It is the third chlorinated *neo*-clerodane from *Teucrium* species, as are² tafricanins A and B, [52] and [53]. Its structure and absolute configuration were confirmed by partial synthesis from eriocephalin [13] and by X-ray analysis of a derivative.

Teuvincentin B [151] possesses a C-7, C-19 hemiacetal group, but its more remarkable feature is the axial 8 β -CH₃ orientation of the C-17 methyl group, as proved by nOe experiments.³⁶ This biogenetically unusual configuration was never previously found in any of the *neo*-clerodane diterpenoids until now isolated from plants belonging to the *Teucrium* genus. The X-ray analysis of the diacetyl derivative of teuvincentin B confirmed both relative and absolute stereochemistry.

The same unusual 8 β -CH₃ configuration was found³⁶ also in teuvincentin C [152], whose absolute stereochemistry was not ascertained.

From the extract of *T. cossonii*, an endemic species of the Balearic Islands, two new products were obtained.³⁷ Teucossin A [153] has C-20 as a CH₂OAc function, and was correlated with a derivative of teucretol [138]. Teucossin B [154] has a C-7, C-20 acetal group, like the C-7, C-20 hemiacetal ring of auropolin [25], but with epimeric configuration at C-20. The stereochemistry at the C-12 centre and the absolute configuration of both teucossins were not ascertained.

The stereostructure of auropolin [25] was established³⁸ by X-ray diffraction as 20*S* (20 α -H, 20 β -OH).

Some chemical transformations of 19-acetylnaphalin [22] and montanin C [8] provided conclusive evidence³⁹ for the absolute configuration of montanin C itself, 12-*epi*-teupolin II [131], teugnaphalodin [69] and teubutilin B [133]: all of them do have the *neo*-clerodane stereochemistry.

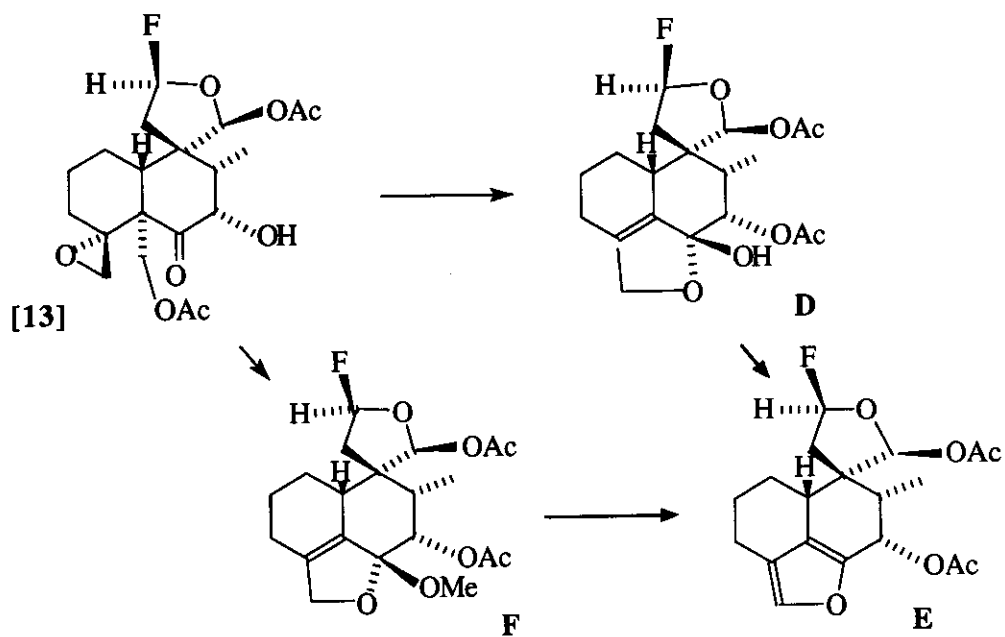
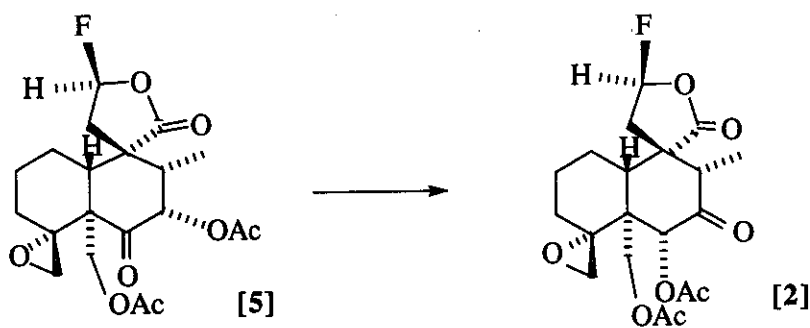
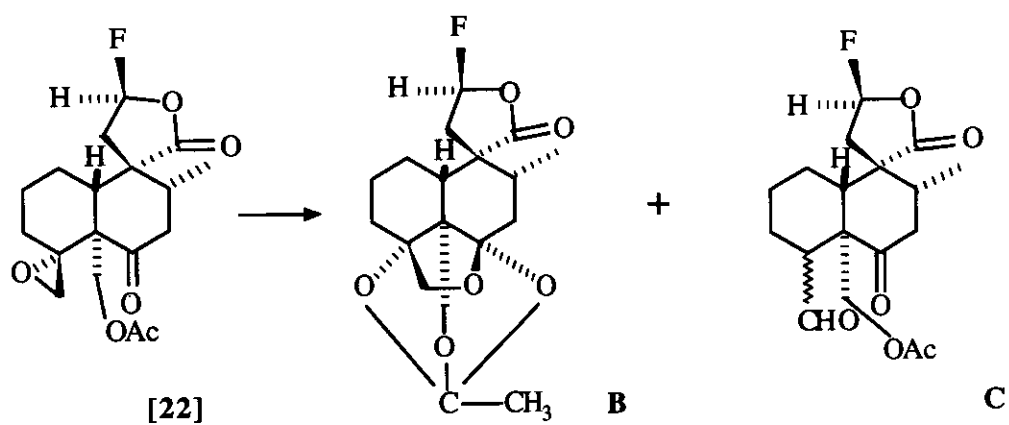
It is remarkable that 37 out of the 51 new derivatives show the 4 α ,18-epoxy system, that after the furan ring and the oxygen function at C-6 is the most common feature of the *neo*-clerodane diterpenoids from *Teucrium*.

Because of the increase of the taxa investigated and of the number of natural derivatives, it is easier and easier to find many already known products in any new species.

So the following known compounds were identified. From *T. pestalozzae*¹⁶ [52]; from *T. odontites*¹⁶ [46], [55], [76]; from *T. microphyllum*¹⁶ [75], [77], [78], [97]; from *T. bidentatum*¹¹ [76], [82], [84], [93]; from *T. gracile*^{19,20} [45], [142]; from *T. oxylepis* subsp. *marianum*²¹ [21], [22], [46], [47], [56], [61], [68], [94], [144], [147]; from *T. lamiifolium*²² [8], [22], [82], [93]; from *T. polium* subsp. *polium*²³ [47], [56], [61]; from *T. abutiloides*²⁶ [8], [131]; from *T. belion*^{29,38} [13], [22], [97]; from *T. massiliense*²⁹ [22], [34]; from *T. divaricatum* subsp. *canescens*³⁰ [46], [74], [75], [76], [78], [80], [93], [95], [97]; from *T. creticum*³¹ [19], [22], [36]; from *T. kotschyianum*³⁴ [46], [68], [76], [85], [91], [93]; from *T. canadense*³⁵ [9], [89], [91], [93], [131]; from *T. polium* subsp. *vincentinum*³⁶ [13], [16], [22], [143]; from *T. polium* subsp. *expansum*³⁷ [4], [45], [124]; from *T. cossonii*³⁷ [135]; from *T. montbretii* subsp. *heliotropifolium* [46], [76], [77], [80]; from *T. asiaticum*³⁸ [25], [93]; from *T. polium* subsp. *capitatum*³⁸ [22], [25]; from *T. polium* subsp. *album*⁴⁰ [8]; from *T. pumilum* subsp. *carolipau*⁴¹ [22]; from *T. turredanum*⁴¹ [13], [16], [22]; from *T. leucocladum*⁴³ [8]; from *T. montbretii* subsp. *montbretii*²⁹ [8], [20], [46], [76], [77], [80], [83], [84], [93], [137].

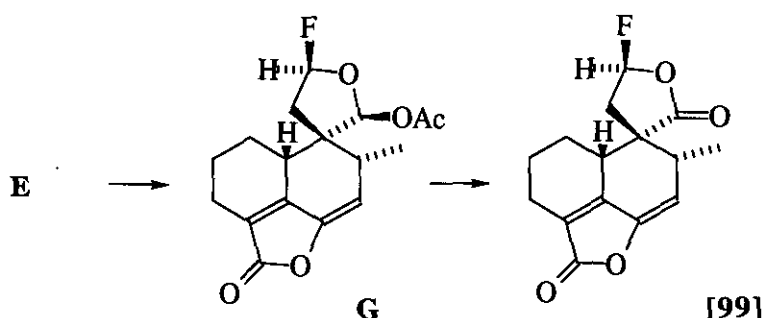
On the contrary, *T. decipiens*,⁴² *T. algarbiense*,⁴³ *T. cyprium*,⁴³ *T. compactum*⁴³ and *T. montbretii* subsp. *pamphilicum*⁴³ were found to contain no diterpenoid.

The *neo*-clerodane absolute configuration was proved conclusively for the majority of the products here reported, by the use of X-ray diffraction, ORD, CD and chemical correlation. In some cases the stereochemistry at C12 was not established when this atom bears an OH or OAc group. When C12 is involved in the five-membered lactone or lactol ring, the configuration is almost always 12*S*. The unusual 12*R* configuration was found only in eleven products: montanin C [8], 12-*epi*-teupolin I [9], teupyrein [28], teusalvin C [57], 12-*epi*-teucvin [90], 12-*epi*-teuscorodonin [121], teucroxylepin [129], 12-*epi*-teupolin II [131], montanin G [134], 12-*epi*-teucvidin [145] and 12-*epi*-teuflin [146].

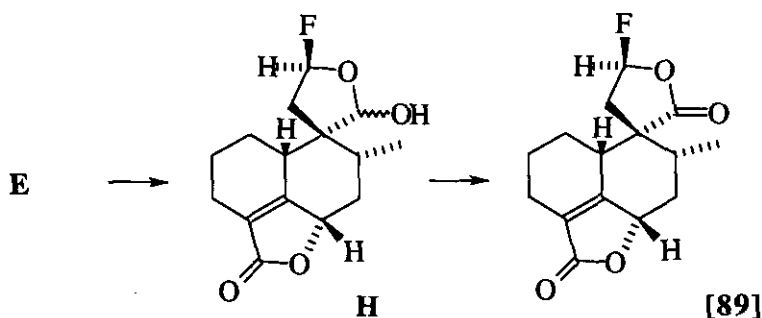


The mechanism of the retroaldolic loss of C-19 by basic catalysis was studied⁴⁷ on eriocephalin [13]. Treatment with potassium *t*.butoxide gave an highly unstable intermediate **D** that dehydrated to the furan derivative **E**; in the presence of methyl iodide the methyl acetal **F** was obtained, that heated at 150°C lost CH₃OH giving **E**. The retroaldolic cleavage is possible only if a keto group occurs on C-6: indeed, in the presence of a 6 α -OH group only the transacetylation from C-19 to C-6 was observed.

Product **E** was oxidized by atmospheric O₂ in CHCl₃ solution to **G**: the latter by hydrolysis followed by CrO₃-Py oxidation yielded⁴⁷ teuscorolide [99].



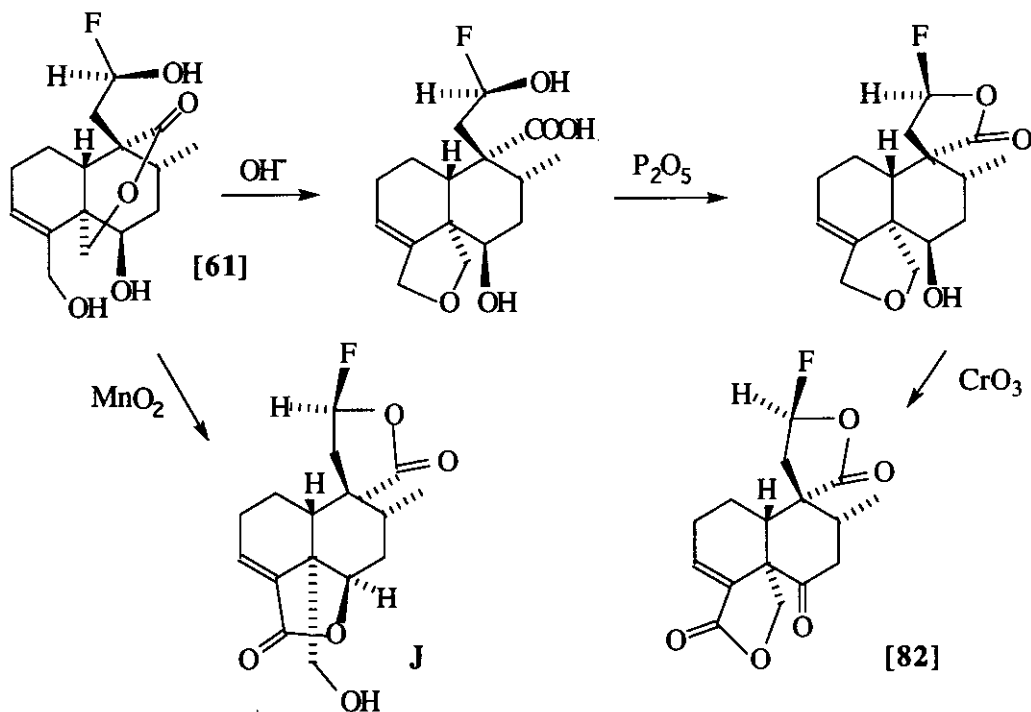
Sulphuric acid hydrolysis of **E** produced⁴⁷ epimerization at C-20 and rearrangement to **H**, whose CrO₃-Py oxidation afforded teucvin [89].



From teubotrin [61] a three-step partial synthesis of teuscordinon [82] was performed.⁴⁸ Oxidation of teubotrin [61] with MnO₂ yielded⁴⁸ a derivative **J** with two γ -lactone rings.

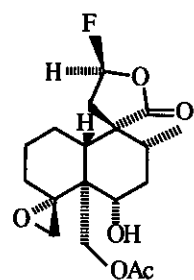
Montanin A [101] was the starting material for a five-step partial synthesis⁴⁹ of crotoaudin, a *neo*-clerodane diterpenoid from *Croton caudatus* (family Euphorbiaceae). So it was proved

that crotoctaudin and isocrotoctaudin have the equatorial 8α -CH₃ stereochemistry, and not the previously assigned⁵⁰ axial 8β -CH₃ configuration.



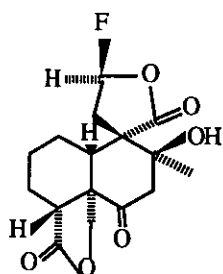
Addendum. The last diterpenoid whose complete stereostructure was elucidated (also by cd and X-ray analysis) is teupernin D, isolated from *T. pernyi* quite recently.⁵¹ It is a 19-*nor* derivative, belongs to the 10α -H series, and shows an unprecedented axial 8α -CH₂Cl and 8β -OH system. Therefore teupernin D [155] is the fourth example of chlorinated *neo*-clerodanes from *Teucrium*..

TABLE



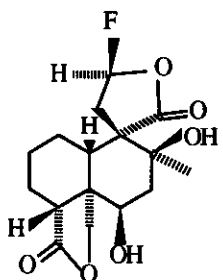
[104] teupolin I
T. polium^{5,6}

$C_{22}H_{28}O_7$



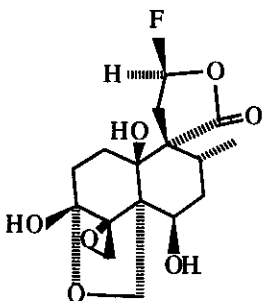
[105] teupernin B
*T. pernyi*¹⁰
*T. bidentatum*¹¹

$C_{20}H_{22}O_7$



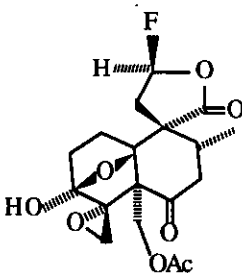
[106] teupernin C
*T. pernyi*¹⁰

$C_{20}H_{24}O_7$



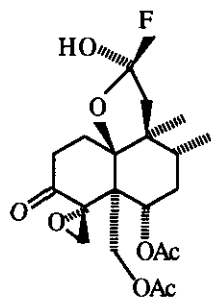
[107] teupestalin A
*T. pestalozzae*¹²

$C_{20}H_{24}O_8$



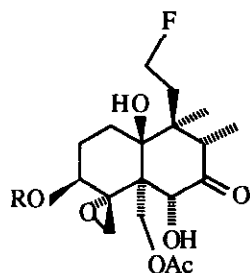
[108] teupestalin B
*T. pestalozzae*¹²

$C_{22}H_{24}O_9$



[109] teucrolivin A
*T. oliverianum*¹³

$C_{24}H_{30}O_9$



[110] teucrolivin B
*T. oliverianum*¹³

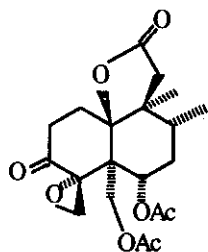
R = Ac

$C_{24}H_{32}O_9$

[111] teucrolivin C
*T. oliverianum*¹³

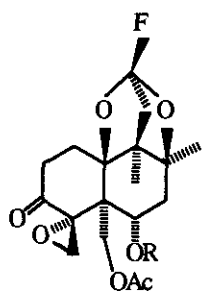
R = H

$C_{22}H_{30}O_8$



[112] teucrolivin F
*T. oliverianum*¹⁴

$C_{20}H_{26}O_8$



[113] teucrolivin H
*T. oliverianum*¹⁵

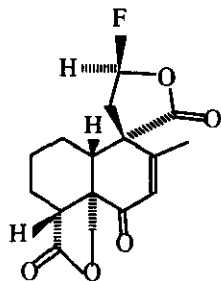
R = H

$C_{22}H_{26}O_8$

[114] teucrolivin G
*T. oliverianum*¹⁵

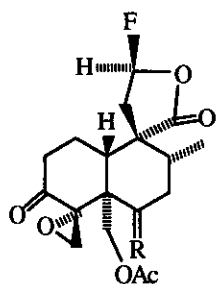
R = Ac

$C_{24}H_{28}O_9$



[115] teupernin A
*T. pernyi*¹⁰

$C_{20}H_{20}O_6$

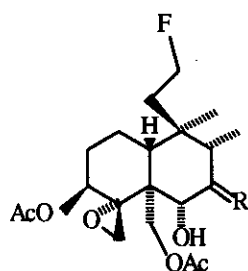


[116] 4 α ,18-epoxytafricanin A R = O C₂₂H₂₄O₈

*T. pestalozzae*¹⁶

[117] 20-oxo-teuflavin R = α H, β OH C₂₂H₂₆O₈

*T. pestalozzae*¹⁶

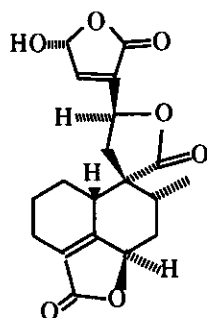


[118] teucroliyin D R = α H, β OAc C₂₆H₃₆O₉

*T. oliverianum*¹⁴

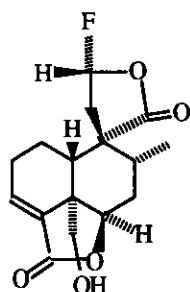
[119] teucrolivin E R = O C₂₄H₃₂O₈

*T. oliverianum*¹⁴



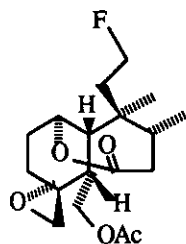
[120] teuponin C₁₉H₂₀O₇

*T. japonicum*¹⁷



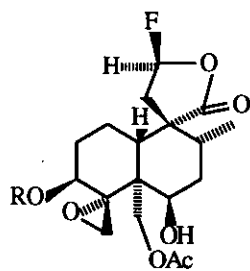
[121] 12-*epi*-teuscorodonin C₂₀H₂₂O₆

*T. bicolor*¹⁸



[122] fruticolide C₂₂H₃₀O₆

*T. fruticans*¹⁹



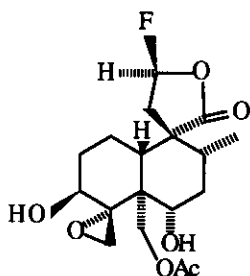
[123] teugracilin A

R = Ac

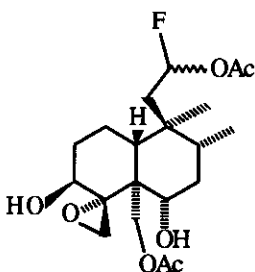
 $C_{24}H_{30}O_9$ *T. gracile*²⁰

[124] 3-O-deacetyl-

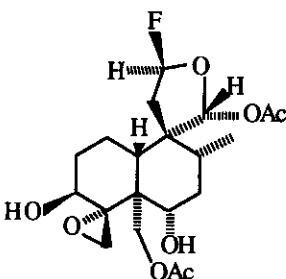
R = H

 $C_{22}H_{28}O_8$ *T. gracile*²⁰*T. polium* subsp. *expansum*³⁷

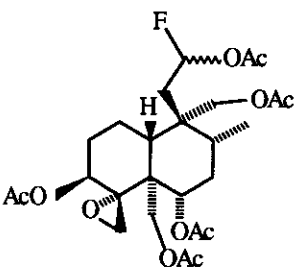
[125] teugracilin B

 $C_{22}H_{28}O_8$ *T. gracile*²⁰

[126] teugracilin C

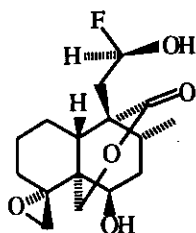
 $C_{24}H_{34}O_8$ *T. gracile*²⁰

[127] teugracilin D

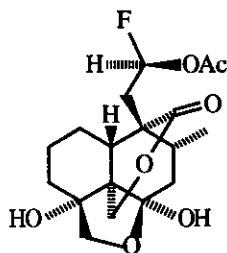
 $C_{24}H_{32}O_9$ *T. gracile*¹⁹

[128] teugracilin E

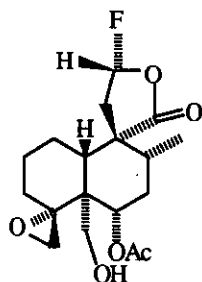
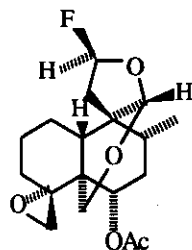
 $C_{30}H_{40}O_{12}$ *T. gracile*¹⁹



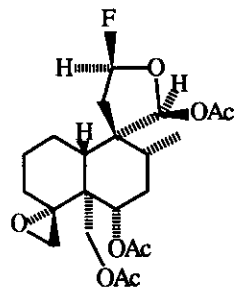
[129] teucroxylepin

 $C_{20}H_{26}O_6$ *T. oxylepis* subsp. *marianum*²¹

[130] 12-acetylteugnaphalodin

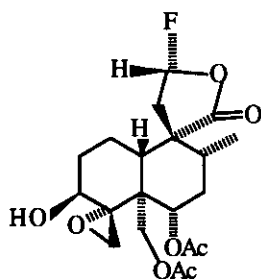
 $C_{22}H_{28}O_8$ *T. oxylepis* subsp. *marianum*²¹[131] 12-*epi*-teupolin II $C_{22}H_{28}O_7$ *T. lamiifolium*²²*T. abutiloides*²⁶*T. canadense*³⁵

[132] teubutilin A

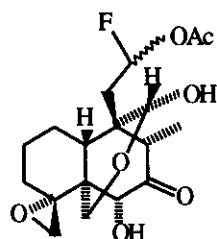
 $C_{22}H_{28}O_6$ *T. abutiloides*²⁶

[133] teubutilin B

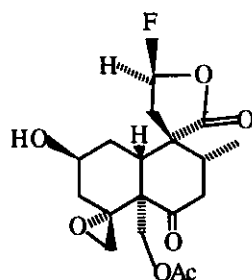
 $C_{26}H_{34}O_9$ *T. abutiloides*²⁶



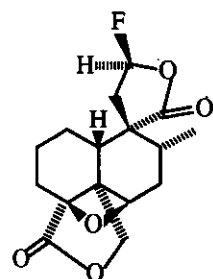
[134] montanin G

 $C_{24}H_{30}O_9$ *T. montanum* var. *skorpilii*²⁷

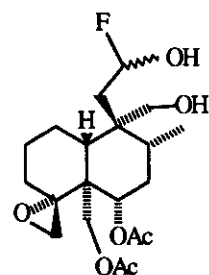
[135] montanin H

 $C_{22}H_{28}O_8$ *T. montanum* subsp. *montanum*²⁸*T. cossonii*³⁷

[136] teumassin

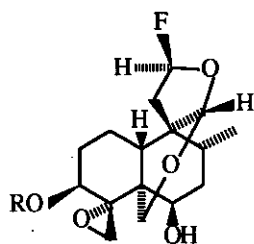
 $C_{22}H_{26}O_8$ *T. massiliense*²⁹

[137] 2-deoxychamaedroxide

 $C_{20}H_{22}O_6$ *T. divaricatum* subsp. *canescens*³⁰

[138] teuretol

 $C_{24}H_{34}O_8$ *T. creticum*³¹



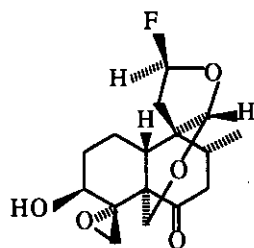
[139] teumicropin

R = H

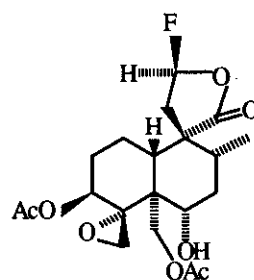
 $C_{20}H_{26}O_6$ *T. micropodioides*³²

[140] 3-acetylteumicropin

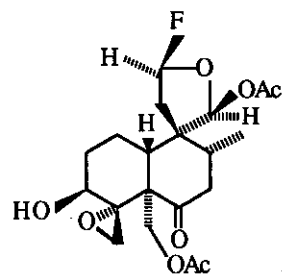
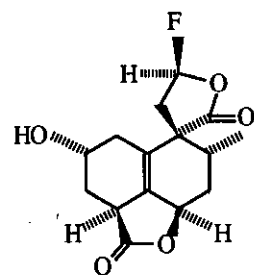
R = Ac

 $C_{22}H_{28}O_7$ *T. micropodioides*³²

[141] 3-O-deacetylteupyrenone

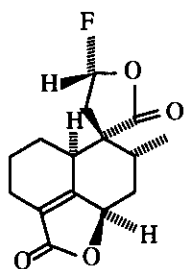
 $C_{20}H_{24}O_6$ *T. micropodioides*³²

[142] teumicropodin

 $C_{24}H_{30}O_9$ *T. micropodioides*³²*T. gracile*²⁰[143] 3-O-deacetyl-20-*epi*-teulanigin $C_{24}H_{30}O_9$ *T. micropodioides*³²*T. polium* subsp. *vincentinum*³⁶

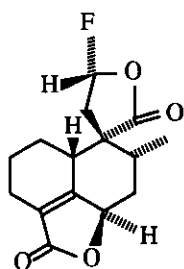
[144] isoteucrin-H4

 $C_{19}H_{20}O_6$ *T. kotschyanum*³³*T. oxylepis* subsp. *marianum*²¹



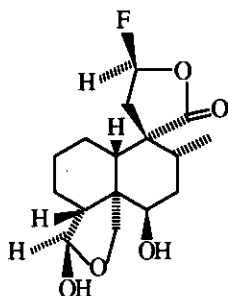
[145] 12-*epi*-teucvidin
*T. kotschy anum*³⁴

C₁₉H₂₀O₅



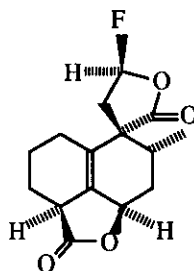
[146] 12-*epi*-teuflin
*T. kotschy anum*³⁴

C₁₉H₂₀O₅



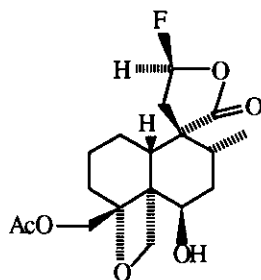
[147] teukotschyn
*T. kotschy anum*³⁴
T. oxylepis subsp. *marianum*²¹

C₂₀H₂₆O₆



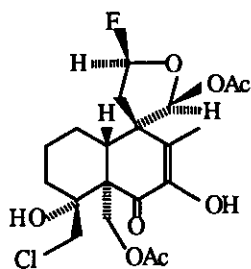
[148] isoteuflin
*T. canadense*³⁵

C₁₉H₂₀O₅

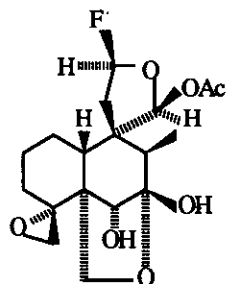


[149] 18-acetylmontanin D
*T. canadense*³⁵

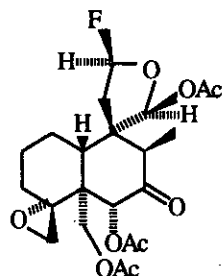
C₂₂H₂₈O₇



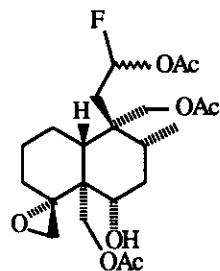
[150] teuvincentin A

 $C_{24}H_{29}O_9Cl$ *T. polium* subsp. *vincentinum*³⁶

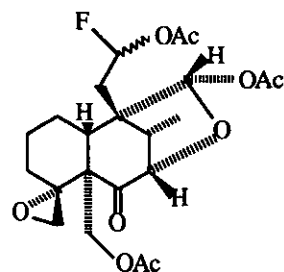
[151] teuvincentin B

 $C_{22}H_{28}O_8$ *T. polium* subsp. *vincentinum*³⁶

[152] teuvincentin C

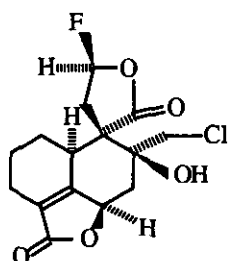
 $C_{26}H_{32}O_{10}$ *T. polium* subsp. *vincentinum*³⁶

[153] teucossin A

 $C_{26}H_{36}O_9$ *T. cossonii*³⁷

[154] teucossin B

 $C_{26}H_{32}O_{10}$ *T. cossonii*³⁷



[155] teupernin D
*T. pernyi*⁵¹

$C_{19}H_{19}O_6Cl$

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