THE PHTHALIDEISOQUINOLINE ALKALOIDS

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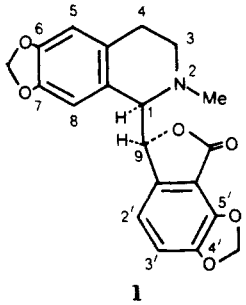
The phthalideisoquinoline alkaloids may be divided into two broad groups, the classical phthalideisoquinolines possessing an intact tetracyclic skeleton and represented by expression **1**, and the secophthalideisoquinolines in which ring B is cleaved resulting in formation of a dimethylaminoethyl side chain.

The classical phthalideisoquinolines are found among members of the Fumariaceae, Papaveraceae, Berberidaceae and Ranunculaceae. Even though asymmetric centers are present in the molecule at C–1 and C–9, the most notable feature of this group is that there is no definite stereochemical preference. Levorotatory, dextrorotatory and racemic erythro or threo natural bases are known.

Over twenty classical phthalideisoquinolines have been isolated. They are all oxygenated at C–6,7,4' and 5', and only the alkaloids narcotine (**14**, **30**) and narcotoline (**16**) bear an extra oxygen at C–8. Cordrastine has been isolated only once, and its characterization is fragmentary. It has, however, been synthesized and resolved and is thus known in optically active and racemic forms.

The absolute configuration of the classical phthalideisoquinolines was established by chemical conversion into tetrahydrobenzylisoquinolines and tetrahydroprotoberberines of known configuration. The relative configuration between the C–1 and C–9 asymmetric centers was derived from ^{1}H nmr chemical shifts. A complete study of the ord and cd curves of the phthalideisoquinolines has been carried out, (28) and ^{13}C nmr spectroscopy (47) may also be of assistance in establishing the relative stereochemistry at C–1 and C–9.



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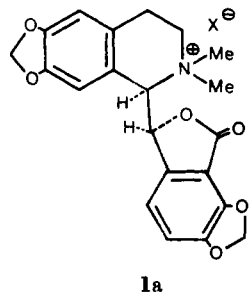

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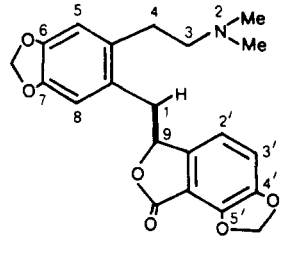

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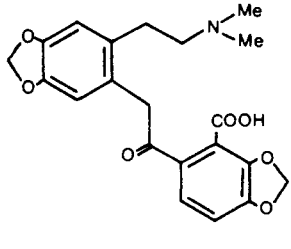

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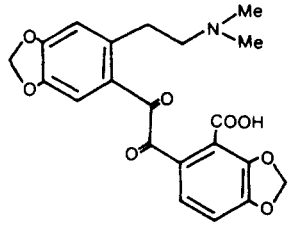

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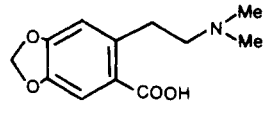

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Classical type phthalideisoquinolines are derived biogenetically from tetrahydroprotoberberines, and the former in turn lead to the secophthalideisoquinolines. The secophthalideisoquinolines may come in different forms including enol lactones, keto lactones, keto acids and diketo acids. The most logical biogenetic sequence appears to be classical type phthalideisoquinoline→classical type phthalideisoquinoline *N*-metho salt→secophthalide enol lactone→secophthalide keto acid→secophthalide diketo acid. Thus if one were to start with (−)-bicuculline (**1**), the sequence would be **1**→(−)-bicuculline *N*-metho salt (**1a**)→the Z enol lactone aobamidine (**32**)→the keto acid adlumidiceine (**36**)→the diketo acid bicucullinine (**42**) (100). A seco diketo acid may then undergo oxidative cleavage to yield the alkaloid fumariflorine (**51**), or one of its analogs. Alkaloids of the fumariflorine type may thus represent a final stage in the catabolism of the phthalideisoquinolines (101). It is worth noting here that the presence of classical type phthalideisoquinoline *N*-metho salts has been detected in *Fumaria parviflora* Lam. (70).

An enol lactone such as aobamidine (**32**) may undergo photoisomerization to a mixture of Z and E isomers, and in fact the E analog of aobamidine is known as a natural product under the name adlumidiceine enol lactone (**33**).

It has recently been shown that secophthalideisoquinoline enol lactones readily react with ammonia to form hydroxy lactams (e.g. fumschleicherine (**50**)). A secophthalide hydroxy lactam can then undergo facile dehydration to an enelactam. Four enelactams have been apparently isolated from natural sources, namely, fumaramine (**45**), fumaridine (**46**), fumaramidine (**48**), and narceine imide (**49**). Since ammonium hydroxide is usually used in the course of the isolation, it seems likely that these four compounds, together with fumschleicherine (**50**), are artifacts of isolation. Until and unless the presence of secophthalideisoquinoline hydroxy lactams and enelactams is conclusively demonstrated in the plant extracts prior to treatment with ammonia, it can be concluded that they are artifacts and not true alkaloids (100). Nevertheless, and for the sake of completeness, the hydroxy lactam fumschleicherine (**50**) and the four enelactams **45**, **46**, **48**, and **49**, have been included in the present listing.

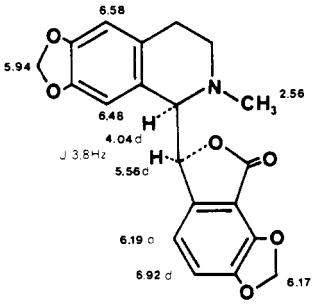
The secophthalideisoquinoline keto acid nornarceine (**40**) may also be another artifact. It is the only known seco base which does not incorporate a complete *N*,*N*-dimethylaminoethyl side chain. It was isolated only once, and that time from opium, and it may very well have arisen from the known *in vitro* N-demethylation of narceine (**39**) in acid solution (100).

All uv data are in nm with log ϵ values between parentheses. Ir frequencies are in cm^{-1}.

The nmr chemical shift δ values quoted are from the first reference cited. However, in case we have found it necessary to modify the original assignment, this has been indicated by a double asterisk (**) as a superscript immediately after the reference. Whenever possible, we have chosen to give very recent nmr spectral data obtained at 200 MHz in lieu of older 60 MHz values. The H-2′ and H-3′ coupling constants have not been given because they are always in the 8.0 to 8.5 Hz range. If other coupling constants are not cited, it is because they are not available in the original literature. Chemical shift values with identical superscripts are interchangeable.

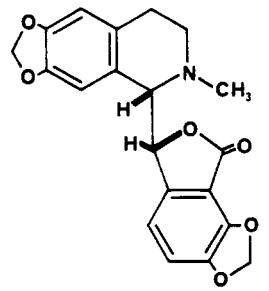
In cases where an alkaloid has been found in different optical forms (+, −, or ±), the sign of the specific rotation is given in brackets immediately before the relevant literature reference. If no rotation is presented, it is only because none has been given in the original paper. Cd and ord data are quoted exactly as stated in the literature.

The numbering system for the classical phthalideisoquinolines adopted here is the one generally accepted. For the sake of convenience, the numbering system for the secophthalideisoquinolines follows that for their classical analogs.



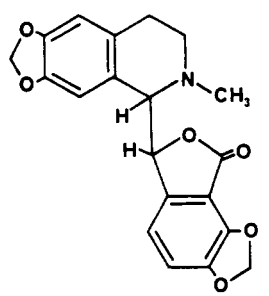
1. (−)-BICUCULLINE

$C_{20}H_{17}NO_6$: 367.1056
erythro (IR,9S)
MP: 193–194° (EtOH) (29)
193–195° (MeOH-acetone) (42)
$[\alpha]^{33}D$: −128° (c 0.27, $CHCl_3$) (29)
$[\alpha]D$: −120° (c 1.0, $CHCl_3$) (29)
$[\alpha]^{33}D$: −110° (c 0.27, $CHCl_3$) (42)
UV: (2-Propanol) 220 (4.47), 235 infl. (4.07), 296 (3.81), 320 (3.74) (29)
IR: (KBr) 1750, 1500, 1490, 1250, 970, 870, 860 (17)
^1H NMR: 200 MHz ($CDCl_3$) (31, 17,29)
ORD: (c 0.184, 0.1N HCl) Φ_{nm} $+260_{650}$, $+320_{589}$, $+200_{348}$ (tr), $+9900_{301}$ (pk), $+4,860_{284}$ (tr), $+26,500_{248}$ (pk), $+25,500_{242}$ (tr), $+29,500_{236}$(pk), $-280,000_{209}$ (tr) (29)
CD: (MeOH) $\Delta\epsilon_{nm}$ -3.25_{321}, -4.02_{248}, $+16.5_{223}$, -21.2_{202} (30)
R_f: 0.40 [benzene-EtOAc (1:1)] (29)
Sources of (−)-bicuculline: See complete listing under (±)-bicuculline (3).



2. (+)-BICUCULLINE

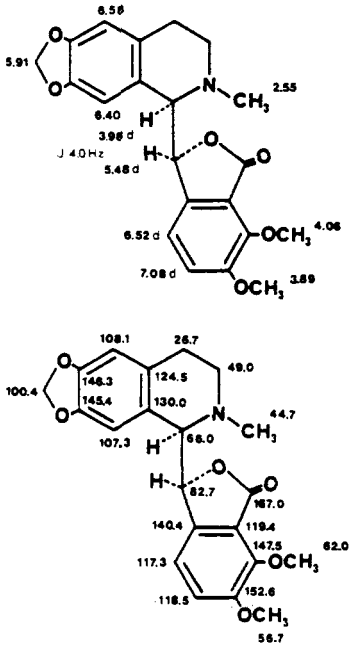
$C_{20}H_{17}NO_6$: 367.1056
erythro (1S,9R)
MP: 194–195° (EtOH) (16)
190–191° (MeOH) (17)
$[\alpha]D$: +137.2° ($CHCl_3$) (17)
$[\alpha]^{20}D$: +132.7° (c 0.049, $CHCl_3$) (22)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $+4,900_{332/318}$, $-6,900_{300/278}$, $+26,400_{258/234}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ $+3.25_{322.5}$, $+2.50_{310i}$, $+2.52_{266i}$, $+3.84_{250}$, -2.98_{235i}, -13.7_{223}, -6.23_{215i}, $+19_{207}$ (28)
R_f: 0.45 [benzene-MeOH (80:20)] (17)
0.40 [CH_2Cl_2-MeOH (98:2)] (17)
Remaining physical properties resemble those of (−)-bicuculline
Sources of (+)-bicuculline: See complete listing under (±)-bicuculline (3).



3. (±)-BICUCULLINE

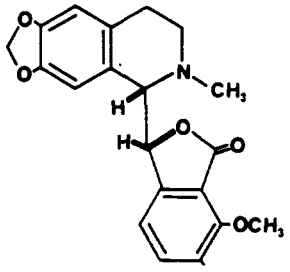
$C_{20}H_{17}NO_6$: 367.1056
erythro racemate (1RS,9SR)
Remaining physical properties resemble those of (−)-bicuculline (excluding ORD, CD, $[\alpha]D$)
Sources of the bicucullines: Fumariaceae: *Corydalis aurea* Willd. (2), *C. caseana* A. Gray (3, 4, 5), *C. crystallina* Engelm. (6), *C. gigantea* Trautv. & Mey. (+) (15), *C. gortschakovii* Schrenk. (+) (16), (56), *C. govaniana* Wall. (+) (17), *C. humosa* Migo (73), *C. lutea* (L.) D.C. (19), (+) (20), *C. marshalliana* (+) (21), *C. nobilis* Pers. (3), *C. ochotensis* var. *raddeana* (22), *C. ochroleuca* Koch. (5), *C. platycarpa* Makino (7), *C. pseudoadunca* Popov (+) (16), *C. remota* (77), *C. scouleri* Hook (8), *C. sempervirens* (L) Pers. (=*C. glauca* Pursh.) (9, 10, 14), *C. severtzovii* Rgl. (−) (42), *C. sibirica* (L.) Pers. (11), *C. vaginans* Royle (77), *Dicentra chrysantha* Walp. (12), *D. cucullaria* (L.) Bernh. (9), *D. ochroleuca* Engelm (12), *Fumaria indica* Pugsley (±) (27),[a] *F. parviflora* Lam. (19), (+) (13, 32, 33),[a] *F. schleicheri* Soy.-Will. (±) (94), (±) (95), *F. vaillantii* Loisl. (19, 24, (+) (25), (+) (26), (−) (79), Papaveraceae: *Adlumia fungosa* Green (=*A. cirrhosa* Rafin) (1, 2).

[a]The names *F. parviflora* and *F. indica* represent the same plant. They have been listed separately in this review, in accord with the names used in the literature.



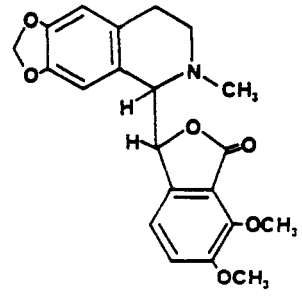
4. (−)-β-HYDRASTINE

$C_{21}H_{21}NO_6$: 383.1368
erythro (1R,9S)
MP: 132° (50, 55)
133–135° (EtOH) (52)
$[\alpha]_D$: −68° (50)
$[\alpha]_D$: −61° (c 1.0, $CHCl_3$) (52)
$[\alpha]_D$: −68° ($CHCl_3$) (55)
$[\alpha]^{18}_{546}$: −68.3° ($CHCl_3$) (49)
UV: (EtOH) 297 (3.86) (52); (MeOH) 295 (3.88) (55)
IR: ($CHCl_3$) 1760, 1601, 1505, 1489, 1385, 1270, 1120, 1043, 1020 (55)
^1H NMR: 200 MHz ($CDCl_3$) (31, 45, 48)
^{13}C NMR: ($CDCl_3$) (47)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $-6{,}300_{325/310}$, $+4{,}000_{296/279}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ -2.76_{311}, -1.73_{266}, $+6.47_{239}$, $+15.64_{217}$, -45.8_{203} (28); (MeOH) $\Delta\epsilon_{nm}$ -3.26_{310}, tr_{290}, -1.98_{265}, $+10.4_{215}$, -46.1_{200} (30)
R_f: 0.76 [*n*-BuOH-CH_3COOH-H_2O (10:1:3)] (54); 0.17 [cyclohexane-diethylamine (9:1)] (54); 0.53 [cyclohexane-$CHCl_3$-diethylamine (7:2:1)] (54)
Sources of (−)-β-hydrastine: See complete listing under (±)-β-hydrastine (**6**).



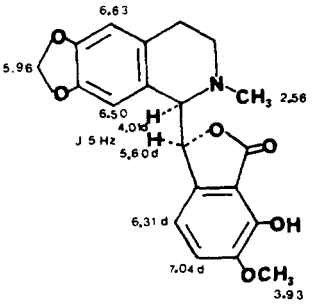
5. (+)-β-HYDRASTINE

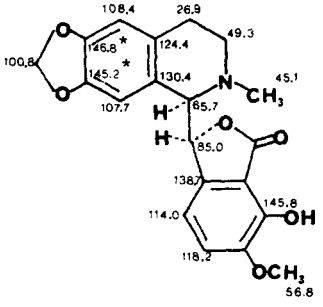
$C_{21}H_{21}NO_6$: 383.1368
erythro (1S,9R)
MP: 131–132° (MeOH) (56)
$[\alpha]^{18}_D$: +63° ($CHCl_3$) (56)
ORD: N.A.
CD: (MeOH) $\Delta\epsilon_{nm}$ $+3.09_{310}$, tr_{290}, $+1.82_{265}$, -16.3_{216}, $+40.1_{200}$ (30)
Remaining physical properties resemble those of (−)-β-hydrastine
Sources of (+)-β-hydrastine: See complete listing under (±)-β-hydrastine (**6**).



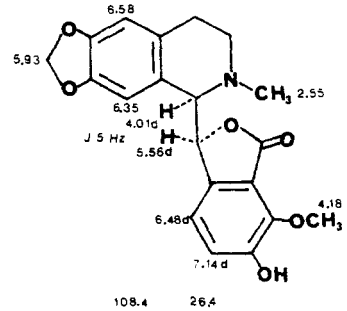
6. (±)-β-HYDRASTINE

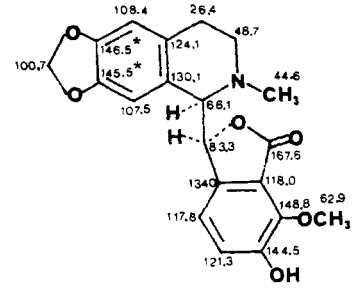
$C_{21}H_{21}NO_6$: 383.1368
erythro racemate (1RS, 9SR)
MP: 153° (EtOH) (49)
151° (51)
Remaining physical properties resemble those of (−)-β-hydrastine (excluding ORD, CD, $[\alpha]_D$).
Sources of the β-hydrastines: Fumariaceae: *Corydalis fimbrillifera* Korsch. (34, 36), *C. gortschakovii* Schrenk (+) (16), *C. pseudoadunca* Popov (+) (16, 4, 6, 56), *C. stricta* Steph. (34), (+) (35), *Fumaria schleicheri* Soy.-Will. (±) (95). Papaveraceae: *Stylomecon heterophylla* (B.) G. Taylor (54). Ranunculaceae: *Hydrastis canadensis* L. (−) (39).
Further sources of the hydrastines (α,β not specified: Berberidaceae: *Berberis laurina* Billb. (37, 38). Ranunculaceae: *Hydrastis canadensis* L. (40, 43, 44).



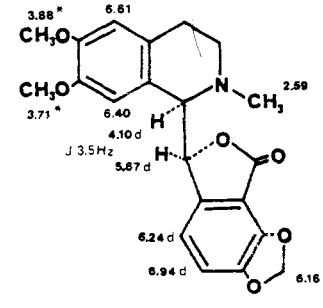


7. (−)-HYDRASTIDINE
$C_{20}H_{19}NO_6$: 369.1212
erythro (1R,9S) (103)
MP: 172–174° (ethyl acetate-hexane) (103)
$[\alpha]^{20}D$: −60.3 (c 0.7, $CHCl_3$) (103)
UV: (MeOH) 296 (3.85), 312 sh (3.72) (103)
IR: ($CHCl_3$) 3500, 1770 (103)
^1H NMR: 60 MHz ($CDCl_3$) (103)
^{13}C NMR: 25.2 MHz ($CDCl_3$) (103)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $-5{,}000_{332}$, $+15{,}000_{298}$, $+42{,}000_{246}$ (103)
Source: Ranunculaceae: *Hydrastis canadensis* L. (103)

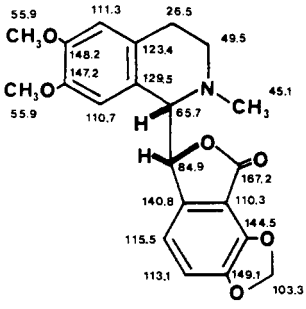




8. (−)-ISOHYDRASTIDINE (Corftaline)
$C_{20}H_{19}NO_6$: 369.1212
erythro (1R,9S)
MP: 163–166° (ethyl acetate-hexane) (103)
$[\alpha]^{20}D$: −77.7° (c 0.6, $CHCl_3$) (103)
UV: (MeOH) 297 (3.84), 312 sh (3.69) (103)
IR: ($CHCl_3$) 3620, 1770 (103)
^1H NMR: 60 MHz ($CDCl_3$) (103)
^{13}C NMR: 25.2 MHz ($CDCl_3$) (103)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $-4{,}500_{333}$, $+11{,}000_{298}$, $+29{,}000_{247}$ (103)
Sources: Fumariaceae: *Corydalis pseudo-adunca* (104). Ranunculaceae: *Hydrastis canadensis* L. (103).
The original Russian reference (104) was not available to the reviewers.

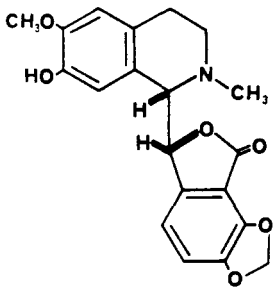


9. (−)-CORLUMINE
$C_{21}H_{21}NO_6$: 383.1368
erythro (1R,9S)
MP: N.A. (obtained as an oil) (33)
$[\alpha]D$: N.A.
UV: (MeOH) 220 (4.49), 235sh (4.21), 293 (3.67), 323 (3.71) (33)
^1H NMR: 200 MHz ($CDCl_3$) (33)
ORD: N.A.
CD: (MeOH) $\Delta\epsilon_{nm}$ -2.46_{325}, $+0.43_{290}$, -1.45_{270}, $+16.3_{235}$, $+23.2_{226}$ (33)
Remaining physical properties resemble those of (+)-corlumine
Source: Fumariaceae: *Fumaria parviflora* Lam. (33)

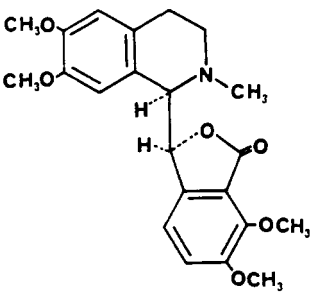


10. (+)-CORLUMINE[b]
$C_{21}H_{21}NO_6$: 383.1368
erythro (1S,9R)
MP: 159° (51, 57)
162° (MeOH) (75)
$[\alpha]^{25}D$: +77° (c 1.0, $CHCl_3$) (75, 8)
UV: (EtOH) 222 (4.49), 287 (3.60), 326 (3.72) (75)
IR: ($CHCl_3$) 1770, 1660, 1567, 1519, 1481, 1256, 1141, 1048, 971 (55)
^1H NMR: ($CDCl_3$) (45, 75)
^{13}C NMR: ($CDCl_3$) (47)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $+6{,}300_{336/316}$, $-4{,}500_{297/279}$, $+27{,}000_{256/242}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ $+2.57_{325}$, $-0.45_{291.5}$, $+1.60_{268}$, $+0.85_{255.5i}$, -17.11_{235i}, -25.36_{226}, -10.5_{215i}, $+39_{205}$ (28); (MeOH) $\Delta\epsilon_{nm}$ $+2.62_{325}$, -0.40_{290}, $+1.80_{268}$, -22.4_{226}, $+35.1_{205}$ (30)
R_f: 0.70 [benzene-MeOH (8:2)] (51)
Sources: Fumariaceae: *Corydalis govaniana* Wall. (75), *C. nobilis* Pers. (3), *C. scouleri* Hook. (8, 73), *C. severtzovii* Rgl. (42, 71, 74), *C. sibirica* (L.) Pers. (11, 64, 73), *Dicentra cucullaria* (L.) Bernh. (3, 9)

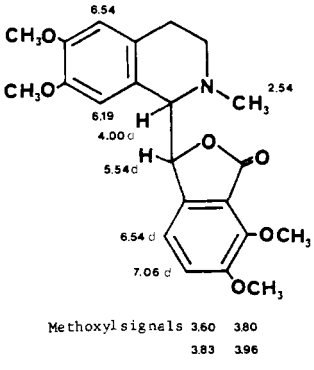
[b](±)-Corlumine has been synthetized; mp 175–176° (98).



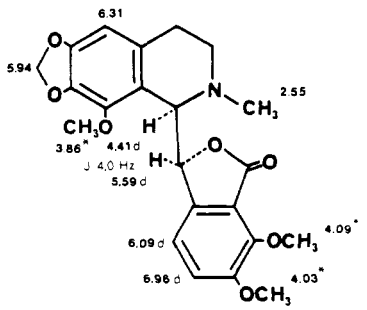
11. (+)-CORLUMIDINE
$C_{20}H_{19}NO_6$: 369.1212
erythro (1S,9R)
MP: 236° ($CHCl_3$) (50, 51, 57, 73)
236° (MeOH) (8)
$[\alpha]^{23}D$: +80° (c 0.4, $CHCl_3$) (8, 50, 57)
UV: 288 (3.70), 320 (3.73) (55)
IR: (Nujol) 3445, 1750, 1598, 1517, 1504, 1030, 973 (55)
^1H NMR: N.A.
ORD: (MeOH) $\Phi_{extrema\ nm}$ $+5{,}200_{343/325}$, $-5{,}900_{300/283}$, $+30{,}200_{256/240}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ $+2.37_{324}$, $+1.68_{310i}$, $+1.81_{270}$, $+2.22_{250.5}$, -10.02_{237i}, -16.03_{227}, -4.7_{214}, $+28_{207}$ (28)
Source: Fumariaceae: *Corydalis scouleri* Hook. (8, 73)



12. (−)-CORDRASTINE II
$C_{22}H_{25}NO_6$: 399.1682
erythro (1R,9S)
MP: 90° (ether-petroleum ether) (29)
$[\alpha]D$: −10° (c 1.0, $CHCl_3$) (29)
UV: (2-propanol) 220 infl (4.35), 235 (4.07), 290 (3.62), 310 (3.53) (29)
ORD: (c 0.415, MeOH) Φ_{nm} $+209_{700}$, $+740_{589}$, -910_{334} (tr), $+11{,}060_{296}$ (pk), $+9370_{255}$ (tr), $+49{,}610_{245}$ (pk), $-245{,}660_{209}$ tr) (29)
CD: (c 0.01M, MeOH) $\Delta\epsilon_{nm}$ 0_{360}, $-7{,}400_{317}$, 0_{292}, $+480_{289}$, 0_{285}, $-2{,}500_{272}$, 0_{261}, $+94{,}200_{222}$, 0_{210}, $-168{,}270_{203}$ (29)
R_f: 0.09 (EtOAc) (29)
Remaining physical properties resemble those of (±)-cordrastine II
Source: Synthetic (29)



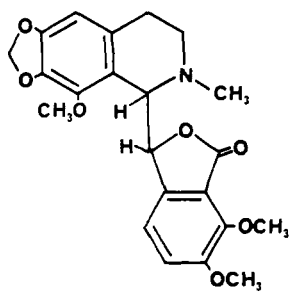
13. (±)-CORDRASTINE II
$C_{22}H_{25}NO_6$: 399.1682
erythro racemate (1RS, 9SR)
MP: 119° (50, 51)
117–118° (MeOH) (76)
IR: ($CHCl_3$) 1755 (76)
^1H NMR: 100 MHz ($CDCl_3$) (76, 97)
Remaining physical properties resemble those of (−)-cordrastine II (excluding ORD, CD, $[\alpha]D$)
Source: synthetic (76, 97)
There is only one report of the isolation of a cordrastine-type alkaloid from a plant (*Corydalis aurea* Willd.). The compound was only partially characterized, and no stereochemistry was assigned (9).



14. (−)-α-NARCOTINE[c, d]

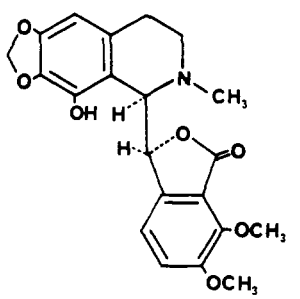
erythro (1R,9S)
MP: 176° (EtOH) (57)
$[\alpha]_D$: −200° ($CHCl_3$) (55)
^1H NMR: 200 MHz ($CDCl_3$) (31)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $+11{,}200_{296/268}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ -4.11_{315}, $-3.35_{305.5i}$, -4.79_{253i}, $-14.22_{235.5}$, -25.5_{228}, $-25_{218.5}$ (28)
Remaining physical properties resemble those of (±)-α-narcotine

[c](±)-α-Narcotine has been synthesized and resolved (83).
[d](+)-α-narcotine, mp 179°C (EtOH), $[\alpha]_D$ +199.92° (83).
$C_{22}H_{23}NO_7$: 413.1474



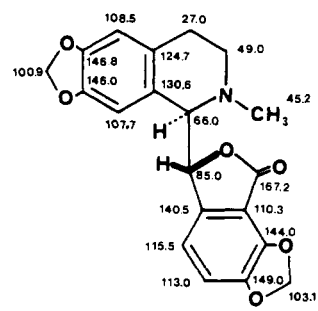
15. (±)-α-NARCOTINE
(±)-α-Gnoscopine

$C_{22}H_{23}NO_7$: 413.1474
erythro racemate (1RS,9SR)
MP: 230–233° (57)
227–230° (EtOH) (78)
UV: 291 (3.60), 309 (3.69) (55)
IR: ($CHCl_3$) 1767, 1607, 1505, 1487, 1040, 1015, 982, 940 (55)
^1H NMR: ($CDCl_3$) (78)
Sources of the narcotines (α,β not specified): Fumariaceae: *Corydalis cava* (L.) Sch. & K. (=*C. tuberosa* D.C.) (55, 59). Papaveraceae: *Papaver fugax* (Turkish origin) (80), *P. paeonifolium* Hort. ex Correa (55), *P. persicum* Lindl. (99), *P. somniferum* L. (=*P. setigerum* D.C.) (55, 57), Poppy straw (81)



16. (−)-NARCOTOLINE

$C_{21}H_{21}NO_7$: 399.1318
erythro (1R,9S)
$[\alpha]_D$: −189° ($CHCl_3$) (57)
UV: 309 (3.68) (55)
IR: (Nujol) 1770, 1537, 1505, 1488, 1278, 1041, 1030, 1010 (55)
^1H NMR, ^{13}C NMR, ORD, CD: N.A.
R_f: 0.68 [isobutanol-H_2O-conc. HCl (21:5:1)] (92)
Sources: Papaveraceae: *Papaver somniferum* (=*P. setigerum* D.C.) (55, 57), Poppy straw (81)

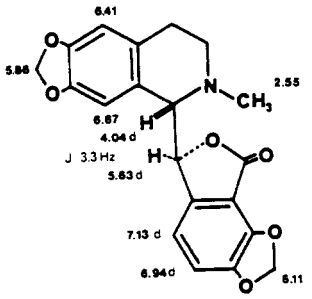


17. (−)-CAPNOIDINE[e]

$C_{20}H_{17}NO_6$: 367.1056
threo (1R,9R)
MP: 238° ($CHCl_3$)-MeOH) (57)
239° (50, 51)
235° ($CHCl_3$-MeOH) (6, 8, 10)
$[\alpha]^{22}_D$: −113.2° (c 0.8, $CHCl_3$) (58)
$[\alpha]^{20}_D$: −116° (c 0.52, $CHCl_3$) (63)
$[\alpha]^{18}_D$: −100° (c 0.52, $CHCl_3$) (16)
UV: 295 (3.84), 321 (3.78) (55); (EtOH) 225 (4.36), 295 (3.72), 325 (3.68) (16); ($CHCl_3$) 295 (3.84), 322 (3.71) (63)
IR: 1750, 1615, 1505, 1040, 1030, 935 (16); ($CHCl_3$) 1768, 1623, 1508, 1045 (55); 1760, 1035, 940 (63)
^1H NMR: (63, 16)
^{13}C NMR: (66)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $+500_{334/320}$, $+8{,}600_{303/283}$, $+23{,}900_{236/240}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ $+0.65_{327.5}$, $+2.42_{296.5}$, $+1.07_{260i}$, $+4.02_{249}$, -7.92_{234i}, -9.75_{224i}, $-19_{208.5}$ (28)
R_f: 0.77 (benzene-MeOH 8:2) (51)

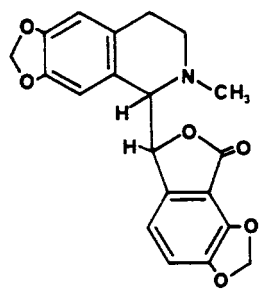
Sources: Fumariaceae: *Corydalis cava* (L.) Sch. & K. (=*C. tuberosa* D.C.) (59), *C. crystallina* Engelm. (6), *C. gigantea* Trautv. & Mey. (15), *C. gortschakovii* Schrenk. (96), *C. marshalliana* (21), *C. pseudoadunca* Popov (16), *C. scouleri* Hook. (8), *C. sempervirens* (L.) Pers. (=*C. glauca* Pursh.) (10, 14), *Fumaria vaillantii* Loisl. (25)

[e]Antipode of (+)-adlumidine (58).



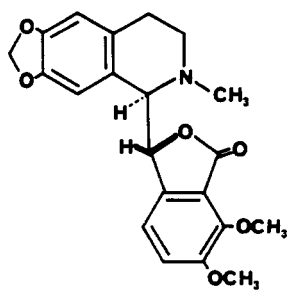
18. (+)-ADLUMIDINE

$C_{20}H_{17}NO_6$: 367.1056
threo (1S,9S)
MP: 239–240°C (acetone) (61)
$[\alpha]^{20}D$: +116.2° (c 2, $CHCl_3$) (58)
^1H NMR: 200 MHz ($CDCl_3$) (33)**
ORD: (MeOH) $\Phi_{extrema\ nm}$ $-3{,}200_{338/317}$, $-8{,}800_{303/281}$, $-27{,}900_{254/239}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ $-.063_{330}$, -2.35_{297}, $-1.38_{259.5}$, $-4{,}11_{249}$, $+6.18_{233}$, $+7.07_{222}$, $+14_{212}$, $+16_{206}$ (28)
Remaining physical properties resemble those of (−)-capnoidine
Sources: Fumariaceae: *Corydalis decumbens* Pers. (18), *C. gigantea* Trautv. & Mey. (77), *C. incisa* Thumb. (1), *C. ochotensis* Turcz. (60, 61, 62), *C. ochotensis* var. *raddeana* (22), *C. ochroleuca* Koch. (23), *C. remota* (77), *C. sibirica* (L.) Pers. (23), *C. thalictrifolia* Franch. (65), *Fumaria indica* (58, 85), *Fumaria parviflora* Lam. (33). Papaveraceae: *Adlumia fungosa* Greene (=*A. cirrhosa* Rafin) (2).



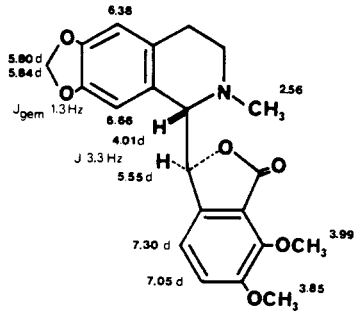
19. (±)-ADLUMIDINE
(±)-Capnoidine

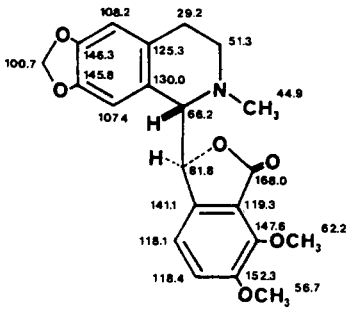
$C_{20}H_{17}NO_6$: 367.1056
threo racemate (1RS,9RS)
MP: 205° ($CHCl_3$-MeOH) (58)
198–199° (benzene:acetone) (98)
184–186° (MeOH) (72)
Source: Fumariaceae: *Corydalis rosea* Leyth. (77).



20. (−)-α-HYDRASTINE
Stylophylline

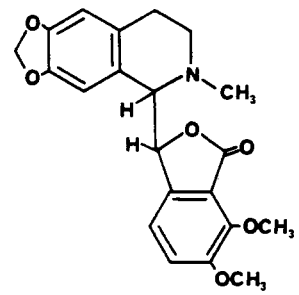
$C_{21}H_{21}NO_6$: 383.1368
threo (1R,9R)
MP: 162–163.5° (52)
162° (50)
$[\alpha]^{18}_{516}$: −163° ($CHCl_3$) (49)
$[\alpha]D$: −141° (c 1.0, $CHCl_3$) (52)
UV: (EtOH) 297.5 (3.86) (52)
ORD: N.A.
CD: (EtOH) $\Delta\epsilon_{nm}$ -1.01_{278}, $+0.34_{256}$, -9.8_{233} (28); (MeOH) $\Delta\epsilon_{nm}$ $+1.94_{307}$ (28)
Remaining physical properties resemble those of (+)-α-hydrastine
Sources of (−)-α-hydrastine: See complete listing under (±)-α-hydrastine (**20**).





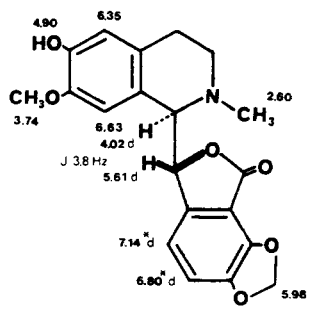
21. (+)-α-HYDRASTINE

$C_{21}H_{21}NO_6$: 383.1368
threo (1S,9S)
MP: 159–161° (EtOH) (33)
$[\alpha]_D$: +127.7° (c 1.1., $CHCl_3$) (26)
UV: 296 (4.90) (26)
IR: 1760, 1610, 1505, 1035, 940 (26)
^1H NMR: 200 MHz ($CDCl_3$) (31, 45)
^{13}C NMR: ($CDCl_3$) (66)
ORD: N.A.
CD: (MeOH) $\Delta\epsilon_{nm}$ -3.44_{302}, $+1.21_{278}$, -1.02_{255}, $+27.0_{213}$, $+13.5_{206}$ (33)
R_f: 0.79[$CHCl_3$-MeOH (8:2)] (26);
0.73 [1-butanol-CH_3COOH-H_2O (100:5:100)] (26);
0.51 [benzene-MeOH (8:2)] (33);
0.51 [ether-MeOH (100:5)] (33)
Sources of (+)-α-hydrastine: See complete listing under (±)-α-hydrastine (**20**).



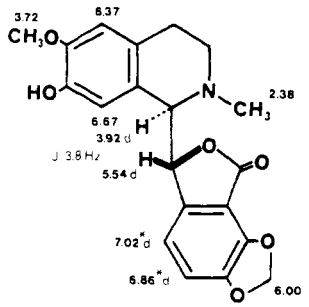
22. (±)-α-HYDRASTINE

$C_{21}H_{21}NO_6$: 383.1368
threo racemate (1RS,9RS)
MP: 137° (51)
149° (49)
Remaining physical properties resemble those of (+)-α-hydrastine (excluding ORD, CD, $[\alpha]_D$)
Sources of the α-hydrastines: Fumariaceae: *Corydalis fimbrillifera* Korsch. (34), *C. stricta* Steph. (34), *Fumaria schleicheri* Soy.-Will. (+) (94), (±) (95), *Fumaria parviflora* Lam. (+) (26), *F. vaillantii* Loisl. (+) (26). Papaveraceae: *Stylomecon heterophylla* (B.) G. Taylor (−) (50). Ranunculaceae: *Hydrastis canadensis* L. (−) (39).
Sources of the hydrastines (α,β not specified): Berberidaceae: *Berberis laurina* Billb. (37, 38). Ranunculaceae: *Hydrastis canadensis* L. (40, 43, 44).

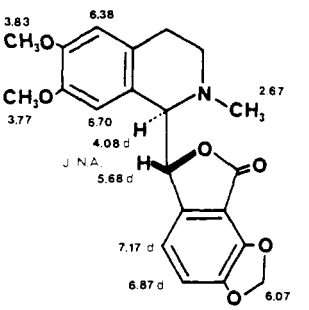


23. (−)-CORLEDINE

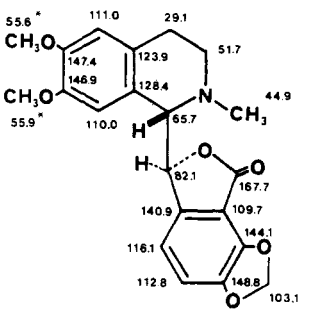
$C_{20}H_{19}NO_6$: 369.1212
threo (1R,9R)
MP: 210–212° (MeOH) (72)
$[\alpha]_D$: −100° (c 0.2, MeOH) (72)
UV: (EtOH) 221 (4.35), 290 (3.44), 326 (3.51) (72)
IR: 3350, 1750, 1610, 1040, 920 (72)
^1H NMR: ($CDCl_3$) (72)
^{13}C NMR: N.A.
ORD: N.A.
CD: ($CHCl_3$) $\Delta\epsilon_{nm}$ $+1.43_{325}$, $+4.35_{292}$, $+6.98_{247}$, -3.82_{288}, -29.2_{205} (30)
Source: Fumariaceae: *Corydalis ledebouriana* K. et K. (72).



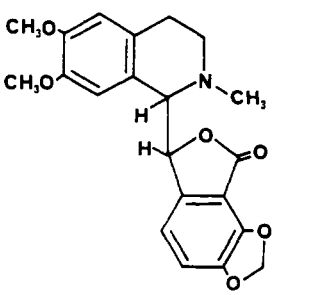
24. (−)-SEVERTZINE
$C_{20}H_{19}NO_6$: 369.1212
threo (1R,9R)
MP: 94–95° (MeOH) (74)
$[\alpha]_D$: −52° (c 0.91, $CHCl_3$) (74)
UV: 221 (4.45), 291 (3.64), 326 (3.76) (74)
IR: 3500, 1760, 1600, 1050, 920 (74)
^1H NMR: 100 MHz ($CDCl_3$) (74)
^{13}C NMR: N.A.
ORD: N.A.
CD: (MeOH) $\Delta\epsilon_{nm}$ $+1.85_{324}$, $+2.40_{293}$, $+8.20_{245}$, -7.35_{220}, -11.7_{205} (30)
Source: Papaveraceae: *Corydalis severtzovii* Rgl. (74).



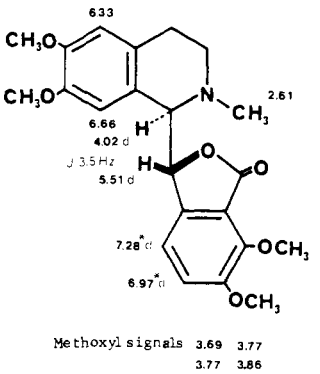
25. (−)-ADLUMINE
$C_{21}H_{21}NO_6$: 383.1368
threo (1R,9R)
MP: 179–180° (MeOH-$CHCl_3$) (16)
179–180° (MeOH) (63)
180° (MeOH-$CHCl_3$) (69)
$[\alpha]^{20}_D$: −51° (c 0.53) (16)
$[\alpha]^{20}_D$: −42° (c 1.8, $CHCl_3$) (63)
UV: ($CHCl_3$) 286 (3.93), 322 (3.99) (63)
IR: 1760 (63)
^1H NMR: 100 MHz ($CDCl_3$) (45)
^{13}C NMR: See (+)-adlumine
ORD: N.A.
CD: (MeOH) $\Delta\epsilon_{nm}$ $+2.08_{320}$, $+4.16_{290}$, $+9.15_{245}$, -1.82_{225}, -28.4_{203} (30)
R_f: 0.47 [benzene-ethyl acetate (9:1)] (63)
Sources of (−)-adlumine: See complete listing under (±)-adlumine (**25**).



26. (+)-ADLUMINE
$C_{21}H_{21}NO_6$: 383.1386
threo (1S,9S)
MP: 180° (51)
$[\alpha]_D$: +42° (CHC_3) (55, 57)
^{13}C NMR: ($CDCl_3$) (47)
ORD: (MeOH) $\Phi_{extrema\ nm}$ $-4{,}100_{337/315}$, $-11{,}000_{301/278}$, $-39{,}700_{254/236}$ (28)
CD: (EtOH) $\Delta\epsilon_{nm}$ $=2.07_{323}$, -4.49_{292}, $-2.32_{261\,i}$, -9.29_{246}, $+0.87_{228.5\,i}$, $+20_{208.5}$ (28)
R_f: 0.88 [benzene-MeOH (8:2)] (51)
Remaining physical properties resemble those of (−)-adlumine
Sources of (+)-adlumine: See complete listing under (±)-adlumine (**25**).

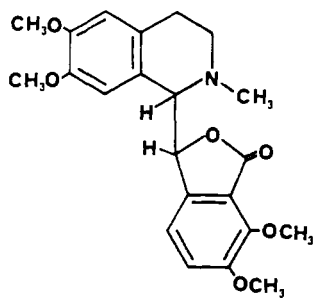


27. (±)-ADLUMINE
$C_{21}H_{21}NO_6$: 383.1368
threo racemate (1RS,9RS)
MP: 175° (MeOH) (63)
190° (57, 98)
Remaining physical properties resemble those of (−)-adlumine (excluding ORD, CD, $[\alpha]_D$)
Sources of the adlumines: Fumariaceae: *Corydalis gigantea* Trautv. & Mey. (77) (−) (15), *C. gortschakovii* Schrenk. (−) (16), *C. ophiocarpa* Hook. & Thoms. (−) (69), *C. rosea* Leyth. (−), (±) (63), (±) (77), *C. scouleri* Hook (−) (8), *C. sempervirens* (L.) Pers. (=*C. glauca* Pursh.) (9, (−) (14), *C. thalictrifolia* Franch. (65), *C. vaginans* Royle (77), *Fumaria kralickii* Jord. (−) (67), *F. parviflora* Lam. (−) (26), *F. rostellata* (+) (68), *F. vaillanti* Loisl. (19, (−) (25). Papaveraceae: *Adlumia fungosa* Greene (=A. *cirrhosa* Rafin) (+) (2).



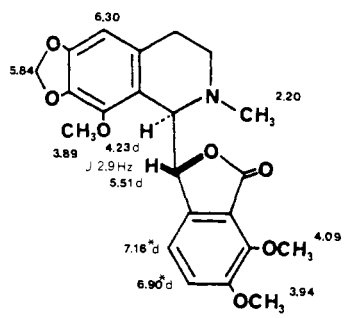
28. (−)-CORDRASTINE I

$C_{22}H_{25}NO_6$: 399.1682
threo (1R,9R)
MP: 196° ($CHCl_3$-MeOH) (9)
189–190° (EtOH) (29)
$[\alpha]_D$: −99° (c 1, $CHCl_3$) (29)
UV: 220 infl (4.50), 290 (3.68), 310 (3.57) (29)
IR: See (±)-cordrastine I
^1H NMR: 100 MHz (29, 76, 97)
ORD: (c 0.367, 0.1N HCl) Φ_{nm} -72_{700}, -96_{589}, $+4620_{328}$ (pk), -9880_{292}(tr), -3670_{264}(pk), -6670_{251} (tr), -5170_{245}(pk), $-99,300_{227}$(tr) (29)
CD: (c 0.009M, 0.1N HCl) $\Delta\epsilon_{nm}$ O_{260}, $+11.3_{310}$, $+0.87_{284}$, $+0.87_{284}$, $+39.13_{238}$, O_{231}, -160.87_{316}, 0_{208} (29)
R_f: 0.58 (EtOAc) (29)
Source: Synthetic (29, 76)



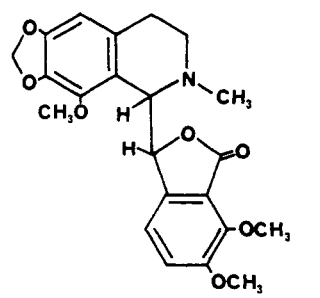
29. (±)-CORDRASTINE

$C_{22}H_{25}NO_6$: 399.1682
threo racemate (1RS,9RS)
MP: 156° (50, 51)
156–157° (MeOH) (76)
IR: ($CHCl_3$) 1760 (76)
Remaining physical properties resemble those of (−)-cordrastine I (excluding ORD, CD, $[\alpha]_D$)
Source: Synthetic (76)
There is only one report of the isolation of a cordrastine-type alkaloid from a plant (*Corydalis aurea* Willd.). The compound was only partially characterized, and no stereochemistry was assigned (9).



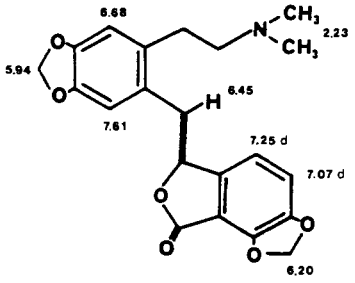
30. (−)-β-NARCOTINE

$C_{22}H_{23}NO_7$: 413.1474
threo (1R,9R)
MP: 181–182° (78)
177–179° (AcOEt) (53)
176° (57)
$[\alpha]_D$: −100° (c 1.00, dioxane) (53)
$[\alpha]_D$: −86° (c 1, $CHCl_3$) (53)
$[\alpha]^{20}_D$: −87.5° (c 1, $CHCl_3$) (78)
UV: (EtOH) 290 (3.58), 3.12 (3.68) (53)
IR: ($CHCl_3$) 1750 (78)
^1H NMR: 60 MHz ($CDCl_3$) (78)
^{13}C NMR: N.A.
ORD: N.A.
CD: (dioxane) $\Delta\epsilon_{nm}$ $+0.2_{329}$, -1.6_{302}, $+1.7_{274}$ (28)
R_f: See (±)-β-narcotine
Source: Synthetic (78)



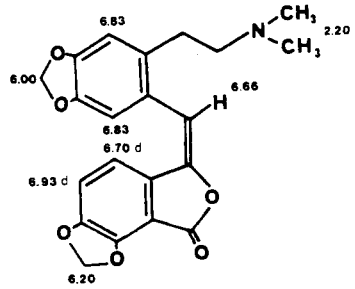
31. (±)-β-NARCOTINE

(±)-β-Gnoscopine
$C_{22}H_{23}NO_7$: 413.1474
threo racemate (1RS,9RS)
MP: 184–186° (EtOH) (78)
180° (51)
R_f: 0.58 [benzene-MeOH (8:2)] (51)
Remaining physical properties resemble those of (−)-β-narcotine (excluding ORD, CD, $[\alpha]_D$)
Sources of the narcotines (α,β not specified): Fumariaceae: *Corydalis cava* (L.) Sch. & K. (= *C. tuberosa* D.C.) (55, 59). Papaveraceae: *Papaver fugax* (Turkish origin) (80), *P. paeonifolium* Hort. ex Correa. (55), *P. persicum* Lindl. (99), *P. somniferum* L. (= *P. setigerum* D.C.) (55, 57), Poppy straw (81).



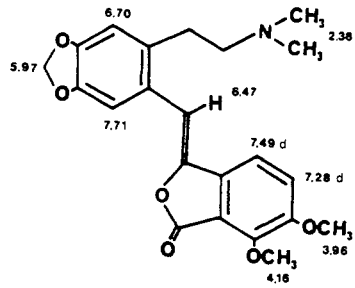
32. AOBAMIDINE

$C_{21}H_{19}NO_6$: 381.1212
MP: 195–197° (Et_2O) (62)
UV: (EtOH) 227 (4.38), 240sh (4.32), 308 (4.10), 337sh (3.94), 390 (4.28) (62)
IR: ($CHCl_3$) 1760 (62)
^1H NMR: 60 MHz ($CDCl_3$) (62)**
MS: 381 (M^+), 336, 204, 177, 58 (62)
Sources: Fumariaceae: *Corydalis lutea* (L.) D.C. (20), *C. ochotensis* var. *raddeana* (62).



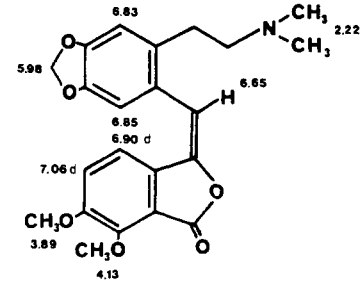
33. ADLUMIDICEINE ENOL LACTONE

$C_{21}H_{19}NO_6$: 381.1212
MP: 200–203° (Et_2O) (84)
UV: (EtOH) 224 (4.45), 238sh (4.39), 306 (4.14), 388 (4.26) (84)
IR: (KBr) 1785 (84)
^1H NMR: ($CDCl_3$) (84)**
MS: Parallels that of adlumidiceine (84)
Source: Fumariaceae: *Corydalis sempervirens* (L.) Pers. (= *C. glauca* Pursh.) (84)



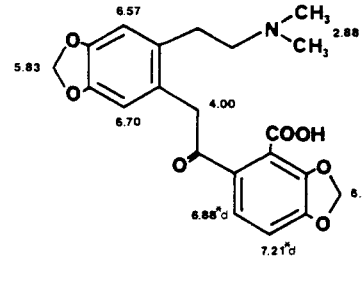
34. N-METHYLHYDRASTINE

$C_{22}H_{23}NO_6$: 397.1525
MP: 156° (19)
UV: (EtOH) 209 (4.38), 228 (4.43), 239sh (4.27), 298 (4.04), 383 (4.21) (19)
IR: (KBr) 1770 (19)
^1H NMR: 200 MHz ($CDCl_3$) (100, 19)
MS: 397 (14.3), 236 (11), 204 (10.2), 58 (100) (100)
R_f: 0.57 [$CHCl_3$-MeOH (100:15)] (100)
Sources: Fumariaceae: *Corydalis lutea* (L.) D.C. (70), *Fumaria officinalis* (19), *F. parviflora* Lam. (32, 70), *F. vaillantii* Loisl. (70).



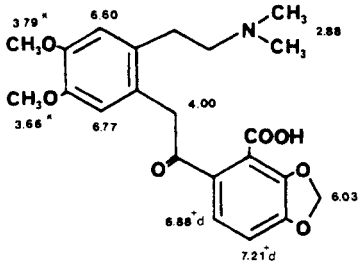
35. E-N-METHYLHYDRASTINE

$C_{22}H_{23}NO_6$: 397.1525
MP: N.A.
VU: (MeOH) 224 (4.32), 232 (4.34) 282 (3.99), 350 (4.05) (100)
UV: ($CHCl_3$) 242 (4.24), 284 (3.98) 353 (4.05) (100)
^1H NMR: 200 MHz ($CDCl_3$) (100)
MS: 397 (29.8), 236 (1.3), 204 (26.0) 58 (100) (100)
R_f: 0.58 [$CHCl_3$-MeOH (100:15)] (100)
Source: Synthetic (100)



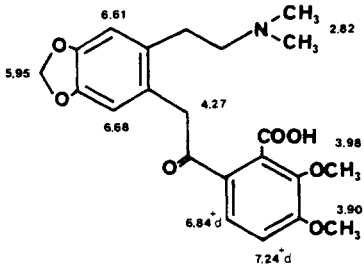
36. ADLUMIDICEINE

$C_{21}H_{21}NO_7$: 399.1318
MP: 244–246° (MeOH) (84, 20)
UV: (EtOH) 232sh (4.14), 294 (3.87), 306sh (3.75) (84)
IR: (KBr) 1691 (dimer), 1609, 1585 (84)
^1H NMR: (CD_3COOD) (84)
MS: 336, 204, 177, 58 (base) (84)
Sources: Fumariacea: *Corydalis sempervirens* (L.) Pers. (= *C. glauca* Pursh) (14, 84), *C. cava* (L.) Sch. & K. (= *C. tuberosa* D.C.) (23, 59), *C. lutea* (L.) D.C. (19, 20), *Fumaria schrammii* (102). Papaveraceae: *Papaver rhoeas* (L.) (84)



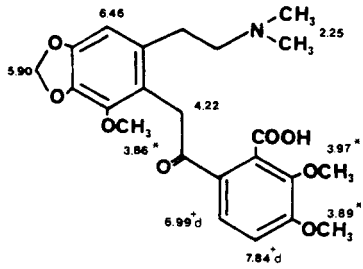
37. ADLUMICEINE

$C_{22}H_{25}NO_5$: 383.1732
The compound was reported in a 1:1 mixture with adlumidiceine (84)
^{1}H NMR: (CD_3COOD) (84)
MS: Similar to that of adlumidiceine (84)
IR, UV: N.A.
Source: Fumariaceae: *Corydalis sempervirens* (L.) Pers. (=*C. glauca* Pursh.) (14, 84), *Fumaria schrammii* (102)



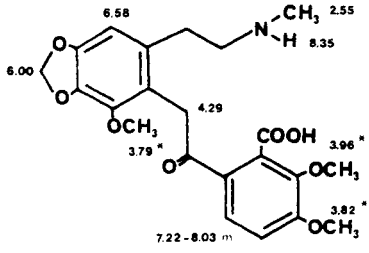
38. N-METHYLHYDRASTEINE

$C_{22}H_{25}NO_5$: 415.1631
MP: 223° (EtOH) (19)
150° (H_2O) (19)
UV: (EtOH) 212 (4.39), 230sh (4.19), 283 (4.27) (19)
IR: (KBr) 1690 (19)
^{1}H NMR: 200 MHz ($CDCl_3$) (100, 19)
MS: 397 (13.6), 352 (1.1), 311 (0.6), 294 (0.7), 280 (0.7), 236 (1.8), 204 (14), 58 (100) (100)
Sources: Fumariaceae: *Corydalis lutea* (L.) D.C. (70), *C. solida* (L.) Swart., (syn. *C. densiflora*) (100), *Fumaria officinalis* (19), *F. parviflora* Lam. (70), *F. vaillantii* Lois. (70).



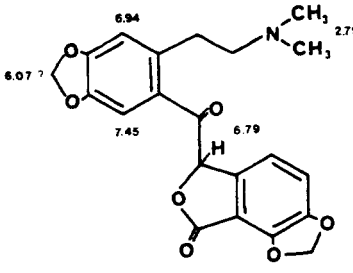
39. NARCEINE

$C_{23}H_{27}NO_8$: 445.1736
MP: 145° (50)
Trihydrate: 155–157° (55)
UV: 272 (4.09) (55)
UV: (MeOH) 220 (4.38), 271 (4.15), 288sh (3.99) (100)
IR: ($CHCl_3$) 3340, 1683, 1583, 1253, 1089, 1059, 995 (55)
^{1}H NMR: 200 MHz ($CDCl_3$) (100)
R_f: 0.92 [isobutyl alcohol-H_2O:conc. HCl (21:5:1)] (92)
Source: Papaveraceae: *Papaver somniferum* L. (=*P. setigerum* D.C.) (55).



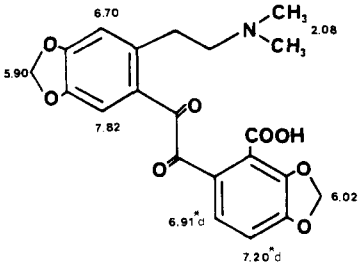
40. NORNARCEINE

$C_{22}H_{25}NO_8$: 431.1580
MP: 229° (50, 55)
223–225° (alcohol) (90)
UV: (EtOH) 209 (4.74), 230 infl (4.34), 273 (4.16) (90)
IR: (Nujol) 1680, 1625, 1590, 1568, 1508, 1323, 1280, 1248, 1058, 1048, 1005, 820 (55); (KBr) 1680, 1620 (90)
^{1}H NMR: 60 MHz (DMSO-d_6) (90)
Source: Papaveraceae: *Papaver somniferum* L. (=*P. setigerum* D.C.) (50)



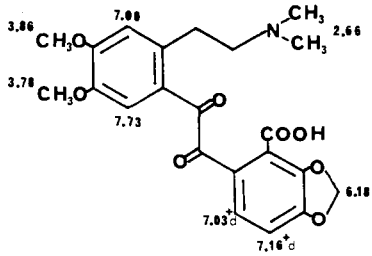
41. NARLUMIDINE

$C_{21}H_{19}NO_7$: 397.1161
MP: 248–250° (85)
$[\alpha]_D$: 0° (MeOH) (85)
UV: 220 (4.43), 235sh (3.57), 285 (3.36), 317 (3.18) (85)
IR: 1765 (85)
PMR: 90 MHz (85)
MS: 220, 177, 58 (85)
Source: Fumariaceae: *Fumaria indica* Pugsley (85)



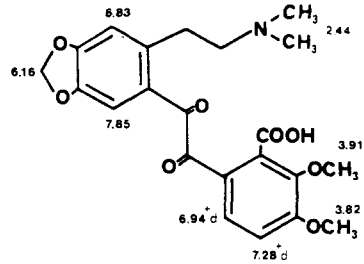
42. BICUCULLININE

$C_{21}H_{19}NO_6$: 413.1110
MP: 268° ($CHCl_3$-MeOH) (5, 88)
264–265° ($CHCl_3$) (93)
UV: 237 (4.39), 292 (4.05), 335 (4.15) (85)
IR: (KBr) 1675, 1625, 1595, 1040 (88)
^1H NMR: 220 MHz (basic D_2O) (88), (DMSO-d_6) (102), CD_3COOD (102)
^{13}C NMR: 28.0 (C-5), 40.5 (N-Me), 56.2 (C-6), 99.3, 99.7 (O-CH_2-O), 104.9, 108.8, 109.4, 118.9, 121.4, 122.4, 122.4, 125.1, 137.8, 142.0, 142.5, 148.9, 149.8 (aromatic carbons), 168.0 (C-8), 190.0, 190.4 (C-13, C-14) (88), (CD_3COOD) (102)
MS: 413 (1), 395 (52), 377 (56), 365 (14), 352 (34), 334 (78), 322 (100), 220 (24), 218 (22), 205 (12), 203 (38), 192 (10), 58 (80) (88)
Sources: Fumariaceae: *Corydalis ochroleuca* Koch. (5, 88), *Fumaria indica* Pugsley (85, 93), *Fumaria schrammii* (102)



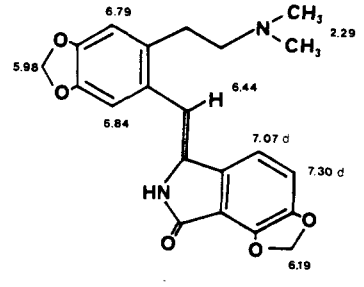
43. BICUCULLINIDINE

$C_{22}H_{23}NO_6$: 429.1423
MP: 265–266° ($CHCl_3$-EtOH) (102)
UV: (MeOH) 294 (3.69), 328 (3.78) (102) (MeOH-H^+) 222sh (4.11), 283 (3.69), 334 (3.85) (102) (MeOH-OH^-) 288 (3.76), 326 (3.81) (102)
IR: (KBr) 1670, 1616, 1591, 1272, 1250, 1202, 1037 (102)
^1H NMR: 80 MHz (DMSO-d_6) (102), (CD_3COOD) (102)
^{13}C NMR: 20.115 MHz (CD_3COOD) at 35° C: 28.5 (C-5), 57.6 (C-6), 109.5, 114.4, 116.3, 123.5, 125.1, 125.6, 129.2, 133.5 (C-1, C-4, C-4a C-8a, C-11, C-12, C-12a, C-14a), 146.9, 147.1, 152.1, 153.1 (C-2, C-3, C-9, C-10), 167.7 (C-8), 187.1, 190.7 (C-13, C-14), 42.2 (N-CH_3), 54.8 (OCH_3), 102.7 (O-CH_2-O) (102), (DMSO-d_6) (102), (D_2O-NaOD) (102)
MS: 429 (⩽0.5), 411 (10), 236 (1), 234 (6), 192 (6), 58 (100) (102)
Source: Fumariaceae: *Fumaria schrammii* (102)



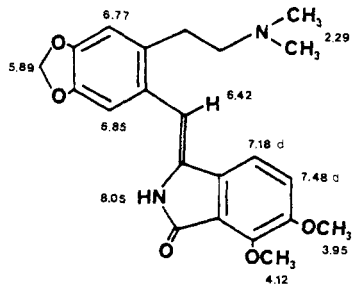
44. N-METHYLOXOHYDRASTEINE

$C_{22}H_{23}NO_6$: 429.1423
MP: 168° (1 mole MeOH) (19)
203° (H_2O) (19)
234–235° ($CHCl_3$-MeOH) (100)
UV: (H_2O) 212 (4.44), 236 (4.40), 298 (4.24), 330sh (4.18) (19)
IR: ($CHCl_3$) 1675 (100)
^1H NMR: 200 MHz ($CDCl_3$) (100, 19)
MS: 411 (6.0), 369 (69.6), 354 (53.1), 341 (13.6), 336 (19.0), 326 (34.2), 310 (17.1), 2.86 (32.2), 267 (11.1), 192 (59.8), 179 (28.0), 58 (100) (100)
Sources: Fumariaceae: *Fumaria officinalis* (19), *F. microcarpa* Boiss. (100).



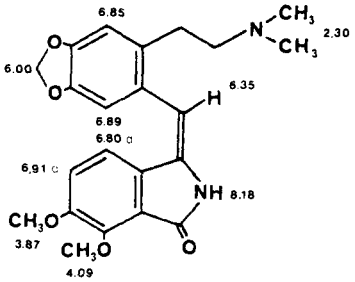
45. FUMARAMINE
(Adlumidiceine imide)

$C_{21}H_{20}N_2O_5$: 380.1372
MP: 227° ($CHCl_3$-MeOH) (5, 88)
220–221° (EtOH) (24, 87)
UV: 226 (4.48), 292 (4.08), 365 (4.38) (24)
IR: (KBr) 3200–2700, 1705, 1250, 1040 (88)
^1H NMR: 200 MHz ($CDCl_3$) (32)**
MS: 335 (3), 293 (2), 204 (12), 58 (100) (88)
R_f: 0.42 [benzene-$CHCl_3$-diethylamine (5:4:1)] (32)
Sources: Fumariaceae: *Corydalis ochroleuca* Koch. (5, 88), *Fumaria parviflora* Lam. (24, 26, 32, 88), *F. vaillantii* Loisl. (24, 25, 88)



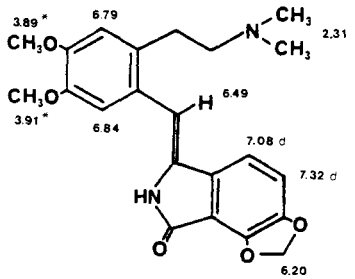
46. FUMARIDINE
(N-Methylhydrasteine imide)

$C_{22}H_{24}N_2O_5$: 396.1685
MP: 189–190° ($CHCl_3$-MeOH) (24)
UV: (EtOH) 228 (4.43), 297 (4.02), 368 (4.35) (24, 87)
IR: ($CHCl_3$) 1705 (87); 1705, 1500, 1040, 935 (24)
^1H NMR: 200 MHz ($CDCl_3$) (100, 32)
MS: 396 (11), 351 (1.3), 204 (17), (58) (100)
R_f: 0.51 [$CHCl_3$-diethylamine (95:5)] (32), 0.45 [$CHCl_3$-MeOH (100:15)] (100)
Sources: Fumariaceae: *Fumaria parviflora* Lam. (24, 26, 32), *F. vaillantii* Loisl. (24, 25)



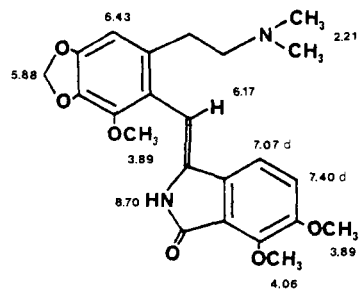
47. E-FUMARIDINE

$C_{22}H_{24}N_2O_5$: 396.1685
MP: 193–194° ($CHCl_3$) (100)
UV: (MeOH) 209 (4.37), 228sh (4.30), 265 (3.98), 345 (4.02) (100)
IR: ($CHCl_3$) 3400, 1710 (100)
^1H NMR: 200 MHz ($CDCl_3$) (100)
MS: 396 (1.7), 351 (1.3), 204 (18.9) 58 (100) (100)
R_f: 0.16 [$CHCl_3$-MeOH (100:15)] (100)
Source: Semi-synthetic (100).



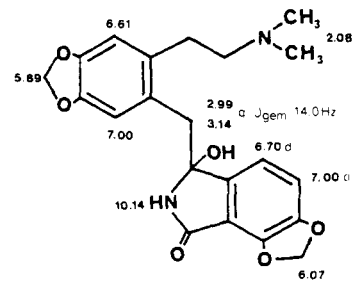
48. FUMARAMIDINE

$C_{22}H_{24}N_2O_5$: 396.1685
MP: N.A.
UV: N.A.
IR: N.A.
^1H NMR: 200 MHz ($CDCl_3$) (32)**
R_f: 0.37 [benzene-$CHCl_3$-diethylamine (5:4:1)] (32)
Source: Fumariaceae: *Fumaria parviflora* Lam. (32)



49. NARCEINE IMIDE

$C_{23}H_{26}N_2O_6$: 426.1790
MP: 150–152° (acetone) (91)
UV: 264 (4.20), 352 (4.20) (91)
IR: 3420, 1710, 1620 1505, 1274, 1055, 1090 (91)
^1H NMR: 60 MHz ($CDCl_3$) (91)
Source: Papaveraceae: *Papaver somniferum* L. (=*P. setigerum* D.C.) (91)



50. FUMSCHLEICHERINE

$C_{21}H_{22}N_2O_6$: 398.1478
MP: 224–226° ($CHCl_3$-EtOH) (86)
UV: (EtOH) 294 (3.6), 314 (3.5) (86)
IR: (Nujol) 3180, 1705 (86)
^1H NMR: 220 MHz (DMSO-d_6) (86)
^{13}C NMR: (DMSO-d_6) (86)
Source: Fumariaceae: *Fumaria schleicheri* Soy.-Will. (86), *Fumaria schrammii* (102).

Alphabetical Listing of the Phthalideisoquinolines.

Adlumiceine (**37**)
Adlumidiceine (**36**)
Adlumidiceine enol lactone (**33**)
(+)-Adlumidine (**18**)
(±)-Adlumidine (**19**)
(−)-Adlumine (**25**)
(+)-Adlumine (**26**)
(±)-Adlumine (**27**)
Aobamidine (**32**)
(−)-Bicuculline (**1**)
(+)-Bicuculline (**2**)
(±)-Bicuculline (**3**)
Bicucullinidine (**43**)
Bicucullinine (**42**)
(−)-Capnoidine (**17**)
(−)-Cordrastine I (**28**)
(±)-Cordrastine (**29**)
(−)-Cordrastine II (**12**)
(±)-Cordrastine II (**13**)
(−)-Corledine (**23**)
(+)-Corlumidine (**11**)
(−)-Corlumine (**9**)
(+)-Corlumine (**10**)
Fumaramidine (**48**)
Fumaramine (**45**)
Fumaridine (**46**)
E-Fumaridine (**47**)
Fumschleicherine (**50**)
(−)-Hydrastidine (**7**)
(−)-Isohydrastidine (**8**)
(−)-α-Hydrastine (**20**)
(+)-α-Hydrastine (**21**)
(±)-α-Hydrastine (**22**)
(−)-β-Hydrastine (**4**)
(+)-β-Hydrastine (**5**)
(±)-β-Hydrastine (**6**)
N-Methylhydrasteine (**38**)
N-Methylhydrastine (**34**)
E-N-Methylhydrastine (**35**)
N-Methyloxohydrasteine (**44**)
Narceine (**39**)
Narceine imide (**49**)
(−)-α-Narcotine (**14**)
(±)-α-Narcotine (**15**)
(−)-β-Narcotine (**30**)
(±)-β-Narcotine (**31**)
(−)-Narcotoline (**16**)
Narlumidine (**41**)
Nornarceine (**40**)
(−)-Severtzine (**24**)

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