Two New Insecticidal Amides and a New Alcoholic Amide from *Piper nigrum* LINN.

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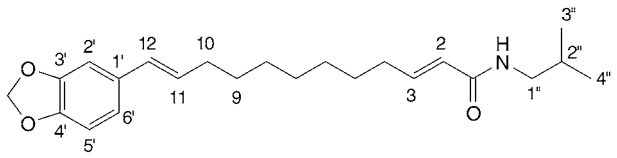
Three new amides, pipgulzarine (**1**), pipzorine (**2**), and piptahsine (**3**), have been isolated from the dried seeds of *Piper nigrum* LINN. along with nine known constituents: (2*E*,4*E*,8*Z*)-*N*-(isobutyl)eicosatrienamide, pellitorine, pipercide, piperine, stigmastanol, stigmasterol, decurrenal, stigmasterol 3-*O*-*β*-D-glucopyranoside, and 5,10(15)-cadinen-4-ol. The structures of the new constituents have been established as *(2*E*,11*E*)-12-(benzo[1,3]dioxol-5-yl)*-N-*(2-methylpropyl)dodeca-2,11-dienamide* (**1**), *(2*E*,12*Z*)*-N-*(4-methylpentyl)octadeca-2,12-dienamide* (**2**), and *(2*E*,4*S*)-4-hydroxy*-N-*(2-methylpropyl)hex-2-enamide* (**3**). The structures of **1**–**3** were derived by spectral studies and chemical reactions, and by comparison of spectral data in the case of known constituents. Compounds **1** and **2**, and most of the already known compounds, exhibited toxicity against fourth instar larvae of *Aedes aegypti* Liston. The isolated *(Z)* double bond in **2** was assigned on the basis of its EI-MS fragmentation pattern and its reaction with OsO_4. The (*S*) configuration at C(4) of **3** was determined by *Horeau*'s method. This is the first report of the isolation of a 4-methylpentylamide from *P. nigrum*, while shorter branched amides have been reported from this genus [1].

Introduction. – *Piper nigrum* LINN., commonly known as black pepper, belonging to the Piperaceae family, is a climbing perennial shrub. It is known to be acrid, pungent, and hot. Some *Piper* species are listed as remedies for stomach pain, asthma, bronchitis, fever, abdominal pain, haemorrhoidal afflictions, rheumatism, as anti-inflammatory and stimulant agents, but also as insect repellents. The chemistry of *Piper* species has been widely investigated, and phytochemical investigations from all parts of the world have led to the isolation of a number of physiologically active compounds, including alkaloids, amides, propenylphenols, lignans, neolignans, terpenes, steroids, pyrones, piperolides, chalcones, flavones, and flavanones [2–5]. As part of our research program towards obtaining plant-based potential insecticides [6], we isolated three new and nine known compounds from the seed extract of *P. nigrum*. The petroleum-ether and EtOH extracts of the fruits exhibited interesting effects on the mosquito *Aedes aegypti*, as determined by the WHO method [7]. The petroleum-ether extract afforded one new compound, pipgulzarine (**1**), and three known compounds: (2*E*,4*E*,8*Z*)-*N*-(isobutyl)-eicosatrienamide [6], pellitorine [6], and pipercide [8]. From the EtOH extract, two new constituents, pipzorine (**2**), and piptahsine (**3**), and six known compounds, piperine [5][6], stigmastanol [9], stigmasterol [9][10], decurrenal [11], a glucoside of stigmasterol [12][13], and 5,10(15)-cadinen-4-ol [14] have been isolated. The structures of compounds **1**–**3** were inferred from the ^{1}H- and ^{13}C-NMR spectral data, including DEPT and 2D-NMR experiments (^{1}H-^{1}H COSY, HMQC, HMBC, and NOESY). The toxicities of **1**, **2**, and pipercide were found to be 6.0, 70.0 and 19.0 ppm, respectively,

against fourth instar larvae of *A. aegypti*. The toxicities of some of the above-mentioned known compounds have been reported earlier [6].



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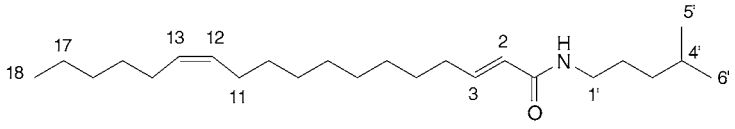

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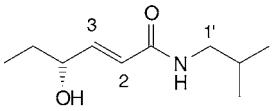

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Results and Discussion. – Pipgulzarine (**1**) formed buff-colored needles from $CHCl_3$/MeOH 1:1, m.p. 98–100°. The HR-EI-MS of **1** showed the molecular ion peak at *m/z* 371 corresponding to the molecular formula $C_{23}H_{33}NO_3$. The IR spectrum showed absorptions for a secondary amide function (3343 cm^{-1}), an amide C=O (1664 cm^{-1}) group, and aromatic and aliphatic C=C resonances (four bands at 1612–1400 cm^{-1}). Characteristic UV-absorption bands at λ_{max} 313.0 ($\varepsilon = 14{,}200$) and 263.4 nm ($\varepsilon = 5{,}450$) were indicative of a conjugated benzo[1,3]dioxol moiety [15]. The signals in the ^{1}H-NMR spectrum of **1** at δ (ppm) 3.15 ($t, J = 6.5$ Hz, $CH_2(1'')$), 1.80 (m, H–C(2'')), and 0.91 ($d, J = 6.7$, Me(3'') and Me(4'')) together with the corresponding ^{13}C-NMR signals at 46.9 (C(1'')), 28.6 (C(2'')), and 20.2 (C(3'') and C(4'')), respectively, revealed a (2-methylpropyl)amido group, supported by fragments in the EI-MS at *m/z* 72 for $C_4H_{10}N$, and 100 for $C_5H_{10}NO$. The ^{1}H-NMR spectrum further showed a broad *s* between 1.35–1.60 ppm, integrating for 10 H-atoms, corresponding, according to ^{13}C-NMR measurements (δ 29.8–30.5), to C(5)–C(9). A broad *m* of four H-atoms at 2.30 ppm was assigned to $CH_2(4)$ and $CH_2(10)$. A one-proton *dt* at 5.77 ($J = 15.0, 1.3$) and a one-proton *dt* at 7.10 ($J = 15.0, 7.0$) were attributed to H–C(2) and H–C(3), respectively, with *trans* geometry. A two-proton *s* at 5.92 ppm was characteristic of a methylenedioxy group attached to an aromatic ring. It showed a cross-peak at 100.9 (CH_2, DEPT) in the HMQC spectrum. The ^{1}H-NMR spectrum further displayed a *dt* at 6.04 ($J = 15.7, 7.0$) and a *d* at 6.28 ($J = 15.7$) attributable to H–C(11) and H–C(12), respectively, with a *trans* geometry. Two *d* at 6.86 ($J = 2.0$) and 6.70 ($J = 8.2$) were assigned to H–C(2') and H–C(5'), respectively, while a *dd* at 6.76 was due to H–C(6') ($J = 8.2, 2.0$). These data led to the assignment of pipgulzarine as *(2*E*,11*E*)-12-(benzo[1,3]dioxol-5-yl)*-N*-(2-methylpropyl)dodeca-2,12-dienamide* (**1**). The observed mass fragments (*Fig. 1*) and the ^{13}C-NMR data (*Table 1*) are consistent with

the assigned structure and match well the values reported for compounds with similar partial structures [8].

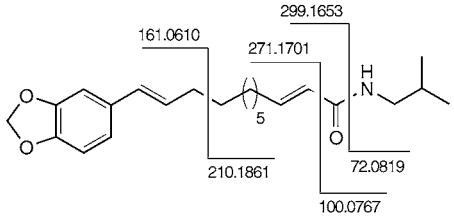


Fig. 1. *Observed HR-EI-MS fragments* (in *m*/*z*) *of pipgulzarine* (**1**)

Table 1. *^{1}H- and ^{13}C-NMR Data of* **1** (in $CDCl_3$; δ in ppm rel. to Me_4Si, *J* in Hz (parentheses))

	δ (^{13}C)	δ (^{1}H)	*J* [Hz]
C(1)	165.0	–	–
H–C(2)	122.2	5.77	*dt* (15.0, 1.3)
H–C(3)	141.1	7.10	*dt* (15.0, 7.0)
CH_2(4)	32.2[a])	2.30	br. *m*
CH_2(5–9)	29.8–30.5	1.35–1.60	br. *s*
CH_2(10)	32.9[a])	2.30	br. *m*
H–C(11)	128.7[b])	6.04	*dt* (15.7, 7.0)
H–C(12)	127.6[b])	6.28	*d* (15.7)
C(1′)	130.1	–	–
H–C(2′)	105.4	6.86	*d* (2.0)
C(3′)	141.8	–	–
C(4′)	141.0	–	–
H–C(5′)	108.2	6.70	*d* (8.2)
H–C(6′)	120.4	6.76	*dd* (8.2, 2.0)
CH_2(1″)	46.9	3.15	*t* (6.5)
H–C(2″)	28.6	1.80	*m*
Me(3″, 4″)	20.2	0.91	*d* (6.7)
OCH_2O	100.9	5.92	*s*
NH	–	5.45	br. *s*

[a]) [b]) Assignments may be interchanged.

Pipzorine (**2**) was obtained as an amorphous powder. It showed a molecular ion at *m*/*z* 363 corresponding to the molecular formula $C_{24}H_{45}NO$, with three degrees of unsaturation. The IR spectrum suggested the presence of a secondary amide (3450 cm^{-1}), an amide C=O (1667 cm^{-1}) and a C=C (1630 cm^{-1}) group. The UV spectrum showed an absorption peak at λ_{max} 209.5 nm ($\varepsilon = 6{,}160$). The geometry and position of the isolated double bond at C(12)/C(13) were determined with the help of EI-MS, ^{1}H-NMR, and ^{13}C-NMR measurements (*Table 2*), and by reaction with OsO_4 and product analysis. The upfield ^{13}C-NMR shifts at δ (ppm) 26.7, 26.9 (C(11), C(14)) suggested the (*Z*)-geometry of the C=C bond [16]. The HR-EI-MS showed fragments with a difference of 14 mass units from *m*/*z* 154.1229–266.2483, followed by a fragment ion at *m*/*z* 292.2639 instead of *m*/*z* 280 (*Fig. 2*), indicating a Δ^{12} double bond [17]. Reaction with OsO_4 afforded hexanal, identified by GC and GC/MS analysis, thus, providing conclusive evidence in favor of a double bond at C(12). The ^{1}H-NMR

spectrum of **2** showed a two-proton *q* at 3.14 ($J = 6.7$, $CH_2(1')$), a one-proton *m* at 1.80 (H–C(4′)), a broad *m* at 1.41–1.60 ($CH_2(2')$ and $CH_2(3')$), and a *d* at 0.91 ($J = 6.7$, Me(5′), Me(6′)). Acid hydrolysis of **2** with concentrated HCl and workup [18] yielded (4-methylpentyl)amine, as found by GC (co-injection of authentic samples of similarly branched amines). Additional support was obtained by fragment-ion peaks at *m*/*z* 100 ($C_6H_{14}N$), 128 ($C_7H_{14}NO$), and 154 ($C_9H_{16}NO$) in the mass spectrum of **2**. The ^{1}H- and ^{13}C-NMR spectra showed the presence of another disubstituted double bond by the signals at 5.75 (*dt*, $J = 15.2$, 1.3, H–C(2)) and 6.92 (*dt*, $J = 15.2$, 6.9, H–C(3)), indicating a conjugated *trans* C=C group. These resonances were connected with δ 122.0 (C(2)) and 139.0 (C(3)) in the HMQC spectrum. The signals at 2.18 (*dq*, $J = 6.9$, 1.3 Hz, $CH_2(4)$) and 1.99–2.03 (*m*, $CH_2(11)$ and $CH_2(14)$) were assigned to three allylic methylene groups. In the light of the above discussion, the structure of **2** was elucidated as *(2*E*,12*Z*)*-N-*(4-methylpentyl)octadeca-2,12-dienamide*.

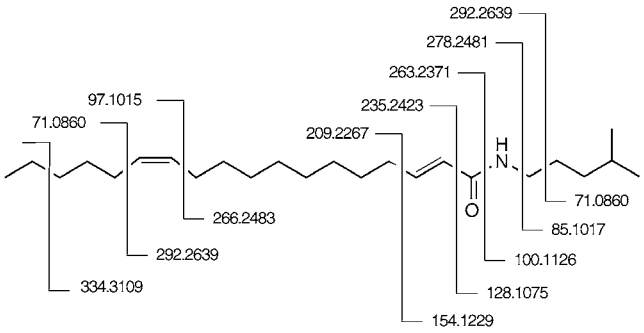


Fig. 2. *Observed HR-EI-MS fragments* (in *m*/*z*) *of pipzurine* (**2**)

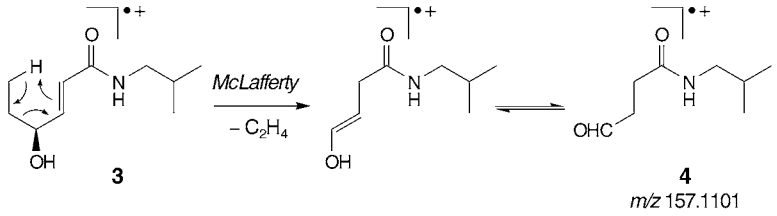
Table 2. *^{1}H- and ^{13}C-NMR Spectral Data of* **2** ($CDCl_3$)

	δ (^{13}C)	δ (^{1}H)	*J* [Hz]
C(1)	165.0	–	–
H–C(2)	122.0	5.75	*dt* (15.2, 1.3)
H–C(3)	139.0	6.92	*dt* (15.2, 6.9)
$CH_2(4)$	31.7	2.18	*dq* (6.9,1.3)
$CH_2(5–10, 15, 16)$	29.0–29.7	1.24–1.33	br. *s*
$CH_2(11)$	26.7[a])	1.99–2.03	*m*
$CH_2(14)$	26.9[a])	1.99–2.03	*m*
H–C(12, 13)	129.5	5.3	*t* (4.9)
$CH_2(17)$	22.3	1.24–1.33	br. *s*
Me(18)	13.5	0.87	*t* (6.7)
$CH_2(1')$	48.5	3.14	*q* (6.7)
$CH_2(2', 3')$	29.0–29.7	1.41–1.60	br. *m*
H–C(4′)	28.7	1.80	*m*
Me(5′, 6′)	19.5	0.91	*d* (6.7)
NH	–	5.43	br. *s*

[a]) Assignments may be interchanged.

Piptahsine (**3**) formed white needles from petroleum ether/AcOEt 7:3. It displayed a molecular-ion peak at *m/z* 185 in the EI mass spectrum, suggesting the molecular formula $C_{10}H_{19}NO_2$ and two degrees of unsaturation. The IR spectrum showed a broad band at 3300–3450 cm^{-1} (secondary amide and OH group), and a band at 1676 cm^{-1} (α,β-unsaturated amide C=O). The UV spectrum showed an absorption at λ_{max} 213.0 nm ($\varepsilon = 6{,}965$). The ^{13}C-NMR spectral data showed the presence of ten C-atoms (three Me, two CH_2, four CH and one C=O group(s)). The signals at 3.15 (*t*, *J* = 6.3, $CH_2(1')$), 1.88 (*m*, H–C(2′)), and 0.85 (*d*, *J* = 7.0, Me(3′) and Me(4′)) in the ^{1}H-NMR spectrum, and their correlated C-resonances at 46.9, 28.3, and 19.9, respectively, in the HMQC spectrum, indicated the presence of a (2-methylpropyl)amido moiety, as supported by the fragment ions at *m/z* 72 ($C_4H_{10}N$) and 100 ($C_5H_{10}NO$) (*cf. Fig. 3*). The ^{1}H- and ^{13}C-NMR spectra (*Table 3*) further showed the presence of a conjugated, disubstituted C=C bond with signals at 6.01 (*dd*, *J* = 15.5, 1.5, H–C(2)), and 6.76 (*dd*, *J* = 15.5, 5.0, H–C(3)). These resonances displayed connectivities with C(2) (124.6) and C(3) (141.5 ppm) in the HMQC spectrum. An interesting feature in the EI-MS of **3** was the base peak at *m/z* 157 ($C_8H_{15}NO_2$) corresponding to N-*(2-methylpropyl)-4-oxobutanamide* (**4**), resulting from *McLafferty* rearrangement [19] (*Scheme*). The (*S*)-configuration at C(4) of **3** was determined by *Horeau*'s method [20].

Scheme



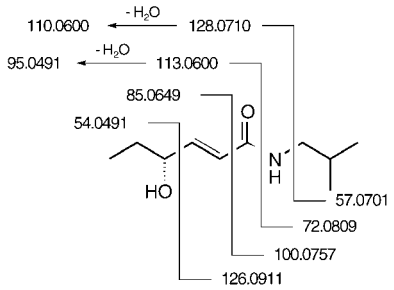


Fig. 3. *Observed HR-EI-MS fragments* (in *m/z*) *of pipthasine* (**3**)

Table 3. *^{1}H- and ^{13}C-NMR Spectral Data of* **3** (in $CDCl_3/CD_3OD$ (trace amount))

	δ (^{13}C)	δ (^{1}H)	J [Hz]
C(1)	166.8	–	–
H–C(2)	124.6	6.01	*dd* (15.5, 1.5)
H–C(3)	141.5	6.76	*dd* (15.5, 5.0)
H–C(OH)(4)	74.2	4.05	*m*
CH_2(5)	32.7	1.22–1.24	*m*
Me(6)	13.8	0.83	*t* (7.0)
CH_2(1′)	46.9	3.15	*t* (6.3)
H–C(2′)	28.3	1.88	*m*
Me(3′, 4′)	19.9	0.85	*d* (7.0)
NH	–	5.50	br. *s*

Experimental Part

General. Vacuum liquid chromatography (VLC): silica gel *60 PF_{254}* (*Merck*). Flash column chromatography (FC): silica gel *9385* (*Merck*, 0.040–0.063 mm). Prep. TLC: silica gel *60 PF_{254}* (*Merck*). GC: *Shimadzu GC-9A* gas chromatograph, FID at 260°, N_2 at 1.0 ml/min, *SPB-5*® capillary column (30 m × 0.53 mm ID; 0.3 μ df); split ratio 1:30, injector temp. 240°; the column temp. was maintained at 50° for the first 5 min and then raised to 240° (3°/min), followed by 5 min at 240°. UV Spectra: *Hitachi U-3200* spectrophotometer; λ_{max} in nm. IR Spectra: *Jasco A-302* spectrophotometer; $\tilde{\nu}$ in cm^{-1}. ^{1}H-NMR Spectra (COSY, NOESY, and *J*-resolved): *Bruker*, 400 MHz; chemical shifts δ in ppm, coupling consants *J* in Hz, referenced to residual solvent signals. ^{13}C-NMR: *Bruker*, 100 MHz. The assignments of *Tables 1–3* are based on ^{1}H-, COSY-45, *J*-resolved, and ^{13}C-(broad-band and DEPT), HMQC, and HMBC spectra. EI-MS: *Finnigan-Mat 311A*; source at 250° and 70 eV; *m*/*z* (%). HR-EI-MS: *Jeol JMS-HX-110*; source at 250° and 70 eV; *m*/*z* (%).

Extraction and Purification: The seeds of *P. nigrum* were purchased from the local market in Karachi.

Air-dried, ground seeds of *P. nigrum* (5 kg) were extracted with petroleum ether (3 × 10 l) at r.t. for 72 h. Evaporation of the combined extracts *in vacuo* afforded a dark brown viscous residue (102.1 g). A portion (91.8 g) of this extract was partitioned between petroleum ether and 90% MeOH. The MeOH phase was extracted with AcOEt after saturation with saline H_2O. The AcOEt layer was dried (Na_2SO_4), and the solvent was evaporated *in vacuo* to give a brownish syrupy concentrate (24.8 g). A portion (11.8 g) of this concentrate was subjected to prep. TLC, yielding eight major bands (petroleum ether/AcOEt 7:3), which were separated by repeated chromatography on precoated thin-layer sheets. *Band 1* (228 mg; petroleum ether/AcOEt 8.5:1.5) furnished three compounds identified as (2*E*,4*E*,8*Z*)-*N*-(isobutyl)eicosatrienamide (32.1 mg), pellitorine (40.3 mg), and pipercide (58.1 mg). *Band 6* (1.15 g) was further split into *Bands 6a*, *6b*, and *6c* in petroleum ether/AcOEt 6:4; each consisting of several spots. *Band 6a* was further purified by prep. TLC (petroleum ether/AcOEt 7:3), affording 11.3 mg of pipgulzarine (**1**), among other mixed products not analyzed. In another batch, dried fruits (10 kg) of *P. nigrum* Linn. were crushed and extracted with EtOH (5 × 10 l) at r.t. After removal of the solvent *in vacuo*, the syrupy residue crystallized overnight as a white solid. On recrystallization from MeOH, it formed fine needles (50.5 g), m.p. 128–129°, and was identified as piperine. The mother liquor of piperine was partitioned between petroleum ether and 70% EtOH. The EtOH phase was extracted with AcOEt after saturation with saline H_2O, and the AcOEt layer was treated with Na_2CO_3 to remove acidic components. The AcOEt layer was washed, dried (Na_2SO_4), and the solvent was evaporated *in vacuo* to give a dark greenish brown syrupy concentrate (159 g), a major portion of which (150 g) was subjected to VLC, eluting with petroleum ether > petroleum ether/AcOEt > AcOEt > $CHCl_3$ > $CHCl_3$/MeOH > MeOH (in increasing order of polarity). In total, 18 fractions (F) were obtained. *F1* (petroleum ether/AcOEt, 9.9:0.1 → 9.0:1.0 eluate; 275 mg) yielded after prep. TLC petroleum ether/AcOEt 9.99:0.01 several bands, two of which were major and, on further purification (petroleum ether/AcOEt 8.5:1.5) resulted in the isolation of pure stigmastanol (3.0 mg) and stigmasterol (3.3 mg). *F2* (petroleum ether/AcOEt, 9.0:1.0 → 8.0:2.0; 383 mg) furnished pure stigmasterol (2.9 mg), decurrenal (1.7 mg), and the 3-*O*-*β*-D-glucoside of stigmasterol (1.6 mg) on repeated prep. TLC in petroleum/AcOEt 8.0:2.0. *F4* (37.0 g) was subjected to CC (petroleum ether/AcOEt > AcOEt > $CHCl_3$ > $CHCl_3$/MeOH > MeOH) to afford 14 fractions (*F1′* to *F14′*). *F1′* to *F3′* tested positive in $CeSO_4$ and negative

in *Dragendorff* tests. *F2′* (petroleum ether/AcOEt 9.5:0.5; 90.0 mg) was purified by prep. TLC (petroleum ether/AcOEt 8.5:1.5) to give 5,10(15)-cadienen-4-ol (1.9 mg). *F3′* (petroleum ether/AcOEt 9.2:0.8; 45.0 mg) mainly gave piperine in petroleum ether/AcOEt (7.5:2.5). *F4′* (petroleum ether/AcOEt 9.0:1.0; 457 mg) gave pipzorine (**2**; 10.7 mg) after prep. TLC on repeated elution with petroleum ether/AcOEt 7.5:2.5). *F6′* (petroleum ether/AcOEt 8.9:1.1; 137 mg) was purified on a small column (petroleum ether > petroleum ether/AcOEt > AcOEt) to obtain 50 fractions (*F1″* to *F50″*). *F39″* (petroleum ether/AcOEt 6.0:4.0) was pure piptahsine (**3**; 5.3 mg) obtained as flowers of needles.

Oxidative Cleavage of **2**. A soln. of **2** (1 mg) in dioxane (0.25 ml) and H_2O (0.15 ml) was treated with OsO_4 (0.3 mg), followed by addition of $NaIO_4$ (2.5 mg) at 25°. After stirring for 2 h at r.t., the mixture was concentrated using a *Sep-Pak* diol cartridge (*Waters*). The sample was then eluted with Et_2O and subjected to GC and GC/MS analysis.

Hydrolysis of **2**. Compound **2** (5 mg) was heated at 100° for 2 d with EtOH (0.5 ml) and conc. HCl (0.5 ml) in a sealed tube. On cooling, the hydrochloride of (4-methylpentyl)amine separated out as fine needles, which, on liberation with NH_4OH and usual workup, gave the free amine as a colorless liquid identified by GC and GC/MS analysis. (3-Methylbutyl)- and (2-methylpropyl)amine for co-injection were purchased from *Merck*; (4-methylpentyl)amine was prepared from isocapronitrile (see below).

Reduction of Isocapronitrile. To a cooled (ice-bath) soln. of $LiAlH_4$ (3.8 g) in anh. Et_2O (200 ml), a soln. of isocapronitrile (12.5 g) in anh. Et_2O (20 ml) was slowly added, and stirring was continued for 75 min. The mixture was diluted with H_2O (4 ml), and 20% aq. NaOH soln. (3 ml) was added. The etheral soln. was decanted from the white, granular inorganic residue. This residue was washed twice with Et_2O, and the combined org. phases were washed, dried (Na_2SO_4), and evaporated at r.t. to afford (4-methylpentyl)amine [21].

Absolute Configuration of **3** *According to* Horeau*'s Procedure*. Pipthasine (2 mg) was added to a soln. of racemic 2-phenylbutanoic anhydride (0.1 ml) in pyridine (0.5 ml). The resulting mixture was stirred for several h at r.t. and left overnight. It was then poured over distilled H_2O (0.3 ml), and the mixture was allowed to stand at r.t. for 30 min. An aq. soln. of NaOH (0.1M) was added dropwise, until the pH was 9.0. The soln. was extracted with $CHCl_3$, the aq. layer was acidified to pH 3 with HCl (1M) and extracted with benzene (10 ml). The benzene extract was dried (Na_2SO_4) and evaporated to a volume of 1 ml. The optical rotation of the resulting 2-phenylbutanoic acid soln. was measured, which showed a positive value (*R*)-configuration, thereby establishing the (*S*)-configuration at C(4) of **3**.

Pipgulzarine (=*(2*E*,11*E*)-12-(Benzo[1,3]dioxol-5-yl)*-N-*(2-methylpropyl)dodeca-2,11-dienamide*; **1**). Yellow crystals. M.p. 98–100°. IR (KBr): 3343, 2850–2900, 1664, 1612, 1482, 1440, 1400, 1140, 890–860, 840–780. UV (MeOH): 313.0 (14,200), 263.4 (5,450). ^{1}H-NMR and ^{13}C-NMR data: *Table 1*. EI-MS: 371 (23.5, M^+), 328 (16), 231 (2), 203 (5), 175 (10), 161 (99), 135 (87), 131 (100), 103 (87), 72 (15), 57 (15.2). HR-EI-MS: 371.2469 (M^+, $C_{23}H_{33}NO_3^+$; calc. 371.2460), 299.1653 ($[C_{19}H_{23}O_3]^+$), 271.1701 ($[C_{18}H_{23}O_2]^+$), 245.1547 ($[C_{16}H_{21}O_2]^+$), 217.1235 ($[C_{14}H_{17}O_2]^+$), 210.1861 ($[C_{13}H_{24}NO_2]^+$), 203.1079 ($[C_{13}H_{15}O_2]^+$), 175.0763 ($[C_{11}H_{11}O_2]^+$), 161.0610 ($[C_{10}H_9O_2]^+$), 135.0451 ($[C_8H_7O_2]^+$), 131.0497 ($[C_9H_7O]^+$), 126.0923 ($[C_7H_{12}NO]^+$), 103.0551 ($[C_8H_7]^+$), 100.0767 ($[C_5H_{10}NO]^+$), 72.0819 ($[C_4H_{10}N]^+$).

Pipzorine (=*(2*E*,12*Z*)*-N-*(4-Methylpentyl)octadeca-2,12-dienamide*; **2**). Amorphous powder. IR (KBr): 3450, 1667, 1630. UV (MeOH): 209.5 (6,160). ^{1}H- and ^{13}C-NMR data: *Table 2*. EI-MS 363 (23.5; M^+), 334 (71), 292 (23.7), 263 (35), 238 (18.2), 181 (21), 167 (19), 166 (53), 154 (62), 153 (22), 139 (21), 138 (94), 128 (25), 125 (29), 111 (67), 100 (39), 97 (50), 71 (75), 69 (94), 67(73), 55 (100). HR-EI-MS: 363.3497 (M^+, $C_{24}H_{45}NO$; calc. 363.3501), 334.3109 ($[C_{22}H_{40}NO]^+$), 320.2951 ($[C_{21}H_{38}NO]^+$), 306.2795 ($[C_{20}H_{36}NO]^+$), 292.2639 ($[C_{19}H_{34}NO]^+$), 278.2481 ($[C_{18}H_{32}NO]^+$), 266.2483 ($[C_{17}H_{32}NO]^+$), 263.2371 ($[C_{18}H_{31}O]^+$), 235.2423 ($[C_{17}H_{31}]^+$), 209.2267 ($[C_{15}H_{29}]^+$), 154.1229 ($[C_9H_{16}NO]^+$), 128.1075 ($[C_7H_{14}NO]^+$), 100.1126 ($[C_6H_{14}N]^+$), 97.1015 ($[C_7H_{13}]^+$), 85.1017 ($[C_6H_{13}]^+$), 71.0860 ($[C_5H_{11}]^+$), 57.0701 ($[C_4H_9]^+$).

Piptahsine (=*(2*E*,4*S*)-4-Hydroxy*-N-*(2-methylpropyl)hex-2-enamide*; **3**). White needles. M.p. 115–116°. IR (KBr): 3300–3450, 1676, 1640, 1460–1440, 1100, 980. UV (MeOH): 213.0 (6,965). ^{1}H- and ^{13}C-NMR data: *Table 3*. EI-MS: 185 (33.5; M^+), 167 (93), 157 (100), 110 (25), 100 (50), 95 (65), 85 (71), 72 (55), 41 (45). HR-EI-MS: 185.1410 (M^+, $C_{10}H_{19}NO_2$; calc. 185.1415), 167.1304 ($[C_{10}H_{17}NO]^+$), 157.1101 ($[C_8H_{15}NO_2]^+$), 139.0991 ($[C_8H_{12}NO]^+$), 128.1081 ($[C_7H_{14}NO]^+$), 128.0710 ($[C_6H_{10}NO_2]^+$), 126.0911 ($[C_7H_{12}NO]^+$), 114.0551 ($[C_5H_8NO_2]^+$), 113.0600 ($[C_6H_9O_2]^+$), 110.0600 ($[C_6H_8NO]^+$), 100.0757 ($[C_5H_{10}NO]^+$), 100.0401 ($[C_4H_6NO_2]^+$), 95.0491 ($[C_6H_7O]^+$), 85.0649 ($[C_5H_9O]^+$), 85.0292 ($[C_4H_5O_2]^+$), 72.0809 ($[C_4H_{10}N]^+$), 57.0701 ($[C_4H_9]^+$), 54.0491 ($[C_3H_7O]^+$).

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