TERPENOID DERIVATIVES OF 4-HYDROXYPROPIOPHENONE AS JUVENOIDS AND JUVENOGENS I.

Jitka KAHOVCOVÁ and Miroslav ROMAŇUK

Institute of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, 166 10 Prague 6

Received September 11th, 1980

Using the reactions modifying the chemical structure of 4-(3,7-dimethyl-2,6-octadienyloxy)-propiophenone and 4-(3,7-dimethyl-2-octenyloxy)propiophenone a number of potential juvenoids and juvenogens were synthetized.

In connection with the study of the effect of chemical structure of synthetic and natural bioanalogues of insect juvenile hormone on their physiological effect we investigated in greater detail the group of aromatic terpenoid ethers.

From the available data on the hormonal juvenilizing activity of the compounds of this group, synthetized by us earlier (compounds *I*–*XII*, Table I), the superiority of monoterpenoid ethers of 4-acylphenols with lower acyl groups clearly emerged. For further chemical modifications of the primary structure of the above-mentioned derivatives we chose therefore 4-(3,7-dimethyl-2,6-octadienyloxy)propiophenone (*I*) and 4-(3,7-dimethyl-2-octenyloxy)propiophenone (*VIII*) as starting compounds. Applying reactions changing the chemical structure of the aliphatic and the aromatic parts of their molecule compounds have been synthetized the often remarkable physiological activity of which led us to the idea of preparing from them their biological precursors-juvenogens as well.

In the preparation of the compounds described in this paper we used oxymercuration with mercuric acetate as the starting modifying reaction for compounds *I* and *VIII*, leading (in the presence of alcohols and after *in situ* demercuration with $NaBH_4$) to 7-alkoxy derivatives *XIV*, *XVI* and *XVIII*–*XXXIII*, and – to a lesser extent – also to 3,7-dialkoxy derivatives *XV* and *XVII*. When aqueous dioxane was used 7-hydroxy derivative *XIII* (Table II) was the reaction product. Compound *XIII* reacted further with acetic anhydride or butyryl chloride in the presence of anhydrous pyridine, affording 7-acyloxy derivatives *XXXIX* and *XL*, while on reaction with 2,3-dihydro-4*H*-pyrane under catalysis with *p*-toluenesulfonic acid it gave 7-(2-tetrahydropyranyloxy) derivative *XXXVIII*. Similarly, acetylation of compound *XXVIII* led to 7-acetoxyethoxy derivative *XLI*. Compounds *XIV* and *XVI* reacted with hydroxylamine to give corresponding oximes *XXXIV* and *XXXV*, and

with O-carboxymethyl ether of hydroxylamine to give compounds *XXXVI* and *XXXVII*.

Compounds *XIII*, *XIV*, *XVI*–*XIX*, *XXVI*, *XXIX* and *XXX* were reduced with $LiAlH_4$ in diethyl ether under formation of hydroxy derivatives *XLII*–*L* (Table III) which on acylation with anhydrides or chlorides of mono- or dicarboxylic acids afforded juvenogens *LII*–*XCVIII* (Table IV). When submitted to acid catalyzed addition of ethyl vinyl ether hydroxy derivative *XLIV* gave its 1-ethoxyethoxy derivative *LI*. On analogous reaction of compound *LXI* with ethyl vinyl ether, 1-ethoxyethyl ester *LXIX* was obtained.

Using the above mentioned modification reactions a number of juvenoids and juvenogens could be prepared which on the basis of their physiological activity in insect metabolism became promising members of a new generation of pesticides.

EXPERIMENTAL

Chromatographic separation of the reaction products was carried out on a column of silica gel (60—120 μm, Service Laboratory of this Institute) with 8 mass % of water or on a column of alumina (Woelm) with 2 mass % of water. The homogeneity of the fractions obtained was checked by TLC on Silica gel G (Merck) and Silufol with a luminescent indicator (Kavalier) and detection with conc. sulfuric acid or inspection under an UV lamp (254 nm wave-length). The boiling points of the compounds are not corrected. The chemical structure of the synthetized compounds was confirmed by elemental analysis or also IR (UR spectrophotometer, CCl_4), mass (AEI MS-902 spectrometer, 70 eV ionization potential) and ^{1}H-NMR (Varian HA 100 instrument, $CDCl_3$, TMS, 100 MHz) spectrometry. The ratio of *cis*- and *trans*-isomers in the case of compound *XVI* was determined by means of GLC on Chromosorb W impregnated with 5% OV-17-1F as stationary phase.

Compounds *I*—*XII*

Powdered KOH (0·01 mol) was added to a solution of *p*-substituted phenol (0·01 mol) in dimethylformamide and when it dissolved alkenyl or alkanedienyl bromide (0·01 mol) was added dropwise under stirring and cooling at room temperature to the solution. The mixture was heated at 60—70°C for 2 h and then allowed to stand at room temperature overnight. After dilution with water the mixture was extracted with diethyl ether, the ethereal layer was washed with 10% aqueous KOH solution and water, dried over anhydrous $MgSO_4$, filtered and evaporated under reduced pressure. The residue was chromatographed on 100-fold amount of silica gel (eluent: light petroleum with increasing amounts of diethyl ether). Some data on compounds *I*—*XII* are surveyed in Table I.

Compounds *XIII*—*XXXIII*

A mixture of compound *I* or *VIII* (0·01 mol) and mercuric acetate (0·01 mol) in 90 ml of anhydrous ethanol, or a mixture of compounds *I* or *VIII* (0·01 mol) in 40 ml of dioxan and mercuric acetate (0·01 mol) in 20 ml of water, was stirred at room temperature for 90 min. After cooling the mixture with ice and addition of 10 ml of 3M-NaOH and a solution of $NaBH_4$ (5 mmol)

TABLE I

Structure and Some Data on Terpenoid Ethers of 4-Acylphenols of the Type T—O—C_6H_4-4-R^1

No	R^1 T	Yield, % b.p., (°C/13 Pa)	Formula (mol.mass)	Calculated/ /Found	
				% C	% H
I[a]	COC_2H_5 $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	59 160—162	$C_{19}H_{26}O_2$ (286·4)	79·67 79·80	9·15 9·06
II[b]	$COCH_3$ $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	50 129—130	$C_{18}H_{24}O_2$ (272·4)	79·37 79·43	8·88 8·80
III[c]	COC_3H_7 $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	55 170—172	$C_{20}H_{28}O_2$ (300·4)	79·95 79·47	9·39 9·22
IV[d]	$COCH(CH_3)_2$ $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	48 169—170	$C_{20}H_{28}O_2$ (300·4)	79·95 79·59	9·39 9·23
V[e]	COC_6H_5 $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	63 188—192	$C_{23}H_{26}O_2$ (334·4)	82·60 82·41	7·84 7·50
VI[f]	$CH{=}CHCOCH_3$ $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	57 145—149	$C_{20}H_{26}O_2$ (298·4)	80·49 80·64	8·78 8·67
VII	$CH_2CH_2COCH_3$ $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}CHCH_2$	51 147—149	$C_{20}H_{28}O_2$ (300·4)	79·95 79·84	9·39 9·33
VIII	COC_2H_5 $(CH_3)_2C{=}CH(CH_2)_2CH(CH_3)(CH_2)_2$	64 167—169	$C_{19}H_{28}O_2$ (288·4)	79·12 79·03	9·78 9·66
IX	COC_2H_5 $(CH_3)_2C{=}CH(CH_2)_2CH(CH_3)$	57 130—132	$C_{17}H_{24}O_2$ (260·4)	78·42 78·19	9·29 9·26
X[g]	COC_2H_5 $(CH_3)_2C{=}CHCH_2$	42 —	$C_{14}H_{18}O_2$ (218·3)	76·97 76·68	8·37 8·07
XI	COC_2H_5 $(CH_3)_2C{=}CHCH(CH_3)$	38 108—110	$C_{15}H_{20}O_2$ (232·3)	77·54 77·57	8·68 8·93
XII	COC_2H_5 $(CH_3)_2C{=}CH(CH_2)_2C(CH_3){=}$ $={=}CH(CH_2)_2CH(CH_3)$	52 187—189	$C_{22}H_{32}O_2$ (328·5)	80·44 80·33	9·82 9·88

[a] M.p. 29—31°C. Mass spectrum: 286 (M^+), 151 ($C_9H_{11}O_2$), 150 ($C_9H_{10}O_2$), 121 ($C_7H_5O_2$), 69 (C_5H_9). ^{1}H-NMR spectrum: δ(ppm): 1·20 (t, 3 H, J = 7·0), 1·60 (s, 3 H), 1·66 (s, 3 H), 1·75 (s, 3 H), 2·10 (m, 4 H), 2·93 (q, 2 H, J = 7·0), 4·59 (m, 2 H), 5·08 (m, H), 5·47 (m, H), 6·92 (m, 2 H, J = 8·5), 7·92 (m, 2 H, J = 8·5); GLC: 80—90% of *trans*-isomer; [b] mass spectrum: 272 (M^+), 137 ($C_8H_9O_2$), 136 ($C_8H_8O_2$), 121 ($C_7H_5O_2$), 69 (C_5H_9); [c] mass spectrum: 300 (M^+), 272 ($C_{18}H_{24}O_2$), 257 ($C_{17}H_{21}O_2$), 165 ($C_{10}H_{13}O_2$), 164 ($C_{10}H_{12}O_2$), 121 ($C_7H_5O_2$), 69 (C_5H_9); [d] mass spectrum: 300 (M^+), 257 ($C_{17}H_{21}O_2$), 165 ($C_{10}H_{13}O_2$), 121 ($C_7H_5O_2$); [e] mass spectrum: 334 (M^+), 199 ($C_{13}H_{11}O_2$), 198 ($C_{13}H_{10}O_2$), 105 (C_7H_5O), 77 (C_6H_5), 69 (C_5H_9); [f] m.p. 48—53°C; [g] m.p. 51—54°C. Mass spectrum: 218 (M^+), 189 ($C_{11}H_{13}O_2$), 150 ($C_9H_{10}O_2$), 121 ($C_7H_5O_2$), 69 (C_5H_9).

TABLE II

Structure and Some Data on 7-Hydroxy-, 7-Alkoxyalkyl-, 7-Alkoxyalkenyl- and 3,7-Dialkoxyalkyl Derivatives of the Type

$(CH_3)_2C(OR^1)(CH_2)_3C(CH_3)=CHCH_2OC_6H_4$-4-$COC_2H_5$

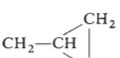
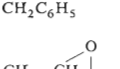
No	R^1	Yield, % b.p., (°C/13 Pa)	Formula (mol.mass)	Calculated/ /Found % C	% H
XIII[a]	H	39 165—168	$C_{19}H_{28}O_3$ (304·4)	74·96 75·28	9·27 9·20
XIV	CH_3	63 166—168	$C_{20}H_{30}O_3$ (318·4)	75·43 75·62	9·50 9·33
XV[b]	CH_3	— 172—175	$C_{21}H_{34}O_4$ (350·5)	71·96 72·08	9·78 9·68
XVI[c]	C_2H_5	42 168—170	$C_{21}H_{32}O_3$ (332·5)	75·86 75·59	9·70 9·84
XVII[b,d]	C_2H_5	— 179—182	$C_{23}H_{38}O_4$ (378·5)	72·97 73·12	10·12 10·29
XVIII[e]	C_3H_7	37 175—178	$C_{22}H_{34}O_3$ (346·5)	76·25 76·30	9·89 9·85
XIX	i-C_3H_7	25 174—177	$C_{22}H_{34}O_3$ (346·5)	76·25 76·38	9·89 9·75
XX[f]		10 219—220	$C_{23}H_{34}O_3$ (358·5)	77·05 76·99	9·56 9·19
XXI	$CH_2C_6H_5$	23 —	$C_{26}H_{34}O_3$ (394·5)	79·14 78·79	8·68 8·90
XXII[g]		7 186—189	$C_{22}H_{32}O_4$ (360·5)	73·30 73·29	8·95 9·17
XXIII	CH_2CF_3	17 172—175	$C_{21}H_{29}F_3O_3$ (386·4)	65·26 65·03	7·56 7·37
XXIV	CH_2CCl_3	15 182—183	$C_{21}H_{29}Cl_3O_3$ (435·8)	57·87 57·57	6·70 6·72
XXV[h]	CH_2CH_2Br	26 195—196	$C_{21}H_{31}BrO_3$ (411·4)	61·31 61·22	7·59 7·52
XXVI	CH_2CH_2Cl	30 —	$C_{21}H_{31}ClO_3$ (366·9)	68·73 68·60	8·51 8·52
XXVII[i]	CH_2CH_2CN	11 219—220	$C_{22}H_{31}NO_3$ (357·5)	73·91 73·62	8·74 8·69

TABLE II
(*Continued*)

No	R^1	Yield, % b.p., (°C/13 Pa)	Formula (mol.mass)	Calculated/ /Found	
				% C	% H
XXVIII[j]	CH_2CH_2OH	29 200—203	$C_{21}H_{31}O_4$ (347·5)	72·58 72·37	8·99 9·23
XXIX	$CH_2CH_2OCH_3$	26 192—194	$C_{22}H_{34}O_4$ (362·5)	72·89 72·91	9·45 9·71
XXX[k]	$CH_2CH_2OC_2H_5$	28 196—198	$C_{23}H_{36}O_4$ (376·5)	73·36 73·70	9·64 9·58
XXXI[l,m]	C_2H_5	22 174—176	$C_{21}H_{34}O_3$ (334·5)	75·40 75·10	10·25 10·11
XXXII[l]	C_3H_7	18 —	$C_{22}H_{36}O_3$ (348·5)	75·81 75·51	10·41 10·72
XXXIII[l,n]	$CH_2—CH(CH_2)CH_2$	15 —	$C_{23}H_{36}O_3$ (360·5)	76·62 76·86	10·06 10·38

[a] M.p. 44—46°C. IR spectrum (5%): 3619 (ν(OH)), 3507 (ν(OH)assoc.), 1697, 1686, 1682 (ν(CO)) cm^{-1}. ^{1}H-NMR spectrum: δ(ppm): 1·21 (t, 3 H, J = 7·0), 1·21 (s, 6 H), 1·74 (s, 3 H), 1·40—1·60 (m, 4 H), 2·10 (m, 2 H), 2·93 (q, 2 H, J = 7·0), 4·60 (d, 2 H, J = 6·5), 5·48 (t, H, J = 6·5), 6·89 (d, 2 H, J = 8·5), 7·90 (d, 2 H, J = 8·5); [b] 3,7-Dialkoxyalkyl compound obtained as a by-product in the preparation of monoalkoxy compound; [c] GLC: 80—90 mass.% of *trans*-isomer. IR spectrum (6%): 1685 (ν(CO)) cm^{-1}. Mass spectrum: 332 (M^+), 317 ($C_{20}H_{29}O_3$), 303 ($C_{19}H_{27}O_3$), 287 ($C_{19}H_{27}O_2$), 183 ($C_{12}H_{23}O$), 151 ($C_9H_{11}O_2$), 150 ($C_9H_{10}O_2$), 121 ($C_7H_5O_2$), 87 ($C_5H_{11}O$); [d] mass spectrum: 378 (M^+), 363 ($C_{22}H_{35}O_4$), 333 ($C_{21}H_{33}O_3$), 288 ($C_{19}H_{28}O_2$), 121 ($C_7H_5O_2$); [e] IR spectrum (5%): 1687 (ν(CO)) cm^{-1}; [f] mass spectrum: 358 (M^+), 343 ($C_{22}H_{31}O_3$), 329 ($C_{21}H_{29}O_3$), 287 ($C_{19}H_{27}O_2$), 209 ($C_{14}H_{25}O$), 150 ($C_9H_{10}O_2$), 137 ($C_{10}H_{17}$), 121 ($C_7H_5O_2$), 113 ($C_7H_{13}O$); [g] mass spectrum: 360 (M^+), 345 ($C_{21}H_{29}O_4$), 331 ($C_{20}H_{27}O_4$), 151 ($C_9H_{11}O_2$), 121 ($C_7H_5O_2$), 115 ($C_6H_{11}O_2$); [h] mass spectrum: 410/2 (M^+), 304 ($C_{19}H_{28}O_3$), 165/7 (C_5H_{10}.BrO), 150 ($C_9H_{10}O_2$), 121 ($C_7H_5O_2$), 107/9 (C_2H_4Br); [i] IR spectrum (4%): 2259 (ν(C≡N)), 1696, 1684 (ν(CO)) cm^{-1}; calculated: 3·91% N; found: 3·73% N; [j] IR spectrum (4%): 3607 (ν(OH)), 3495 (ν(OH)assoc.), 1696, 1687, 1683 (ν(CO)) cm^{-1}; [k] mass spectrum: 376 (M^+), 361 ($C_{22}H_{33}O_4$), 347 ($C_{21}H_{31}O_4$), 151 ($C_9H_{11}O_2$), 131 ($C_7H_{15}O_2$), 121 ($C_7H_5O_2$); [l] 7-alkoxyalkyl compound; [m] ^{1}H-NMR spectrum: δ(ppm): 1·04 (t, 3 H, J = 7·0), 1·06 (s, 6 H), 1·06 (t, 3 H, J = 7·0), 1·08 (d, 3 H, J = 6·0), 1·20—2·00 (m, 9H), 2·87 (q, 2 H, J = 7·0), 3·28 (q, 2 H, J = 7·0), 3·97 (m, 2 H), 6·83 (d, 2 H, J = 8·5), 7·85 (d, 2 H, J = 8·5); [n] IR spectrum (4%): 1686 (ν(CO)), 1604, 1578, 1515 (ν arom.), 1381, 1364 ($\delta_s CH_3$), 1172, 1069 cm^{-1}. Mass spectrum: 360 (M^+), 345 ($C_{22}H_{33}O_3$), 331 ($C_{21}H_{31}O_3$), 290 ($C_{19}H_{30}O_2$), 204 ($C_{13}H_{16}O_2$), 150 ($C_9H_{10}O_2$), 121 ($C_7H_5O_2$), 113 ($C_7H_{13}O$), 55 (C_4H_7).

in 8 ml of 3M-NaOH the mixture was stirred at room temperature for another 3 h, then diluted with water and extracted with light petroleum or a mixture of light petroleum and ether 1 : 1. The extract was washed with water, dried over $MgSO_4$ and evaporated under reduced pressure. The residue was separated on a hundredfold amount (by mass) of silica gel, using light petroleum with increasing amounts of diethyl ether as eluent.

TABLE III

Structure and Some Data on 1-[4-(7-Hydroxy-, 1-[4-(7-Alkoxyalkenyl- and 1-[4-(3,7-Dialkoxyalkyloxy)phenyl]propanol of the Type

$$(CH_3)_2C(OR^1)(CH_2)_3C(CH_3)=CHCH_2OC_6H_4\text{-}4\text{-}CH(OH)C_2H_5$$

No	R^1	Yield, % b.p., (°C/13 Pa)	Formula (mol.mass)	Calculated/ /Found	
				% C	% H
XLII[a]	H	77 160—163	$C_{19}H_{30}O_3$ (306·4)	74·46 74·34	9·86 9·67
XLIII	CH_3	83 157—160	$C_{20}H_{32}O_3$ (320·5)	74·96 75·13	10·06 10·03
XLIV	C_2H_5	88 160—162	$C_{21}H_{34}O_3$ (334·5)	75·40 75·47	10·24 10·28
XLV[b]	C_2H_5	81 185—188	$C_{23}H_{40}O_4$ (380·6)	72·58 72·49	10·59 10·43
XLVI[c]	C_3H_7	85 170—172	$C_{22}H_{36}O_3$ (348·5)	75·81 75·75	10·41 10·29
XLVII	i-C_3H_7	80 171—174	$C_{22}H_{36}O_3$ (348·5)	75·81 75·68	10·41 10·65
XLVIII	CH_2CH_2Cl	81 —	$C_{21}H_{33}ClO_3$ (368·9)	68·36 68·31	9·02 9·28
XLIX	$CH_2CH_2OCH_3$	84 —	$C_{22}H_{36}O_4$ (364·5)	72·48 72·30	9·95 9·94
L	$CH_2CH_2OC_2H_5$	82 —	$C_{23}H_{38}O_4$ (378·5)	72·97 72·85	10·12 9·80

[a] ^{1}H-NMR spectrum: δ(ppm): 0·90 (t, 3 H, J = 7·0), 1·22 (s, 6 H), 1·40—1·90 (m, 4 H,) 1·74 (s, 3 H), 1·80 (m, 2 H), 2·08 (m, 2 H), 4·55 (d, 2 H, J = 6·5), 5·49 (t, H, J = 6·5), 5·54 (t, H, J = 7·0), 6·88 (d, 2 H, J = 8·5), 7·26 (d, 2 H, J = 8·5); [b] 3·7-Diethoxyalkyl compound. Mass spectrum: 380 (M^+). 365 ($C_{22}H_{37}O_4$), 362 ($C_{23}H_{38}O_3$), 347 ($C_{22}H_{35}O_3$), 334 ($C_{21}H_{34}O_3$), 288 ($C_{19}H_{28}O_2$), 251 ($C_{15}H_{23}O_3$), 123 ($C_7H_7O_2$), 87 ($C_5H_{11}O$); [c] IR spectrum (5%): 3621 (ν(OH)), 3475 (ν(OH)assoc.) cm^{-1}.

Some of the products of this reaction were also synthetized using the reaction of the corresponding alkoxyalkyl bromide (0·01 mol) with potassium 4-propionylphenoxide (0·01 mol) in dimethylformamide at 60—70°C for 2 h and then standing at room temperature overnight. The mixture was diluted with water and extracted with diethyl ether. The residue of the extract was worked up as above. The required alkoxyalkyl bromide was prepared[1] from 3,7-dimethyl--6-octenol on reaction with 2,3-dihydro-4*H*-pyrane or ethyl vinyl ether, under catalysis with *p*-toluenesulfonic acid and subsequent solvolytic mercuration-demercuration and final reaction with bromine in the presence of triphenyl phosphite. Some data on compounds *XIII*—*XXXIII* are surveyed in Table II.

Compounds *XXXIV* and *XXXV* (ref.[2])

Powdered NaOH (0·02 mol) was added to a solution of compound *XIV* or *XVI* (0·01 mol) in 96% ethanol at 15—20°C and under stirring and when all NaOH went into solution NH_2OH. .HCl (0·03 mol) was added to the mixture. This was allowed to stand overnight, the major part of ethanol was eliminated by vacuum distillation and the residue was partitioned between diethyl ether and a saturated solution of $NaHCO_3$. After washing, drying, filtering and evaporation of the ethereal layer the residue was separated by column chromatography on a hundredfold amount of alumina with light petroleum with increasing amount of diethyl ether as eluent. *XXXIV*: b.p. 188—189°C/13 Pa; yield 77%. For $C_{20}H_{31}NO_3$ (333·5) calculated: 72·03% C, 9·37% H, 4·20% N; found: 72·24% C, 9·38% H, 4·41% N. *XXXV*: b.p. 189—190·5°C/13 Pa; yield 86%; for $C_{21}H_{33}NO_3$ (347·5) calculated: 72·58% C, 9·57% H, 4·03% N; found: 72·69% C, 9·60% H, 4·12% N. IR spectrum (5%): 3 602 (ν(OH)), 1 673 (ν(C═C)), 1 607 (ν(C═N)) cm^{-1}. Mass spectrum: 347 (M^+), 332 ($C_{20}H_{30}NO_3$), 302 ($C_{19}H_{28}NO_2$), 165 ($C_9H_{11}NO_2$), 148 ($C_9H_{10}NO$), 93 (C_6H_6O), 87 ($C_5H_{11}O$).

Compounds *XXXVI* and *XXXVII* (ref.[2])

Sodium acetate (0·04 mol) was added to a solution of compound *XIV* or *XVI* (0·01 mol) in 90% ethanol under stirring, and after dissolution followed by NH_2OCH_2COOH.1/2 HCl (0·02 mol). The mixture was refluxed for 30 min, cooled to room temperature and partitioned between diethyl ether and 1% aqueous K_2CO_3 solution. From the residue of the ethereal layer the product was obtained in the above mentioned manner. *XXXVI*: yield 40%. For $C_{22}H_{33}NO_5$ (391·5) calculated: 67·49% C, 8·50% H; found: 67·24% C, 8·71% H. *XXXVII*: yield 42%. For $C_{23}H_{35}NO_5$ (405·5) calculated: 68·11% C, 8·70% H; found: 68·44% C, 8·53% H. IR spectrum (4%): 1 764, 1 732 (ν(CO)), 1 676 (ν(C═C)), 1 610 (ν(C═N)) cm^{-1}. Mass spectrum: 405 (M^+), 390 ($C_{22}H_{32}$. NO_5), 360 ($C_{21}H_{30}NO_4$), 223 ($C_{11}H_{13}NO_4$), 148 ($C_9H_{10}NO$), 120 (C_7H_6NO), 93 (C_6H_6O), 87 ($C_5H_{11}O$).

Compounds *XLII*—*L*

A solution of compound *XIII*, *XIV*, *XVI*—*XIX*, *XXVI*, *XXIX* or *XXX* (0·01 mol) in anhydrous diethyl ether was added dropwise and under stirring at 10—20°C to a suspension of $LiAlH_4$ (5 mmol, 20% excess) in diethyl ether. The mixture was refluxed for 30 min, cooled with ice, diluted with diethyl ether and unreacted hydride was decomposed under stirring with icy water and 10% aqueous sulfuric acid. The ethereal layer was separated and washed with a saturated NaCl solution, dried over $MgSO_4$ and evaporated under reduced pressure. The residue obtained was separated by column chromatography in the above described manner. Some data on compounds *XLII*—*L* are given in Table III.

TABLE IV

Structure and Some Data on the Esters of 1-[4-(7-alkoxyalkenyl- and 1-[4-(3,7-dialkoxyalkyloxy)-phenyl]propanol of the Type

$$(CH_3)_2C(OR^1)(CH_2)_3C(CH_3)=CHCH_2OC_6H_4\text{-}4\text{-}CH(OCOR^2)C_2H_5$$

No	R^2	Yield, %	Formula (mol.mass)	Calculated/ /Found	
				% C	% H
	7-Methoxy derivative ($R^1 = CH_3$)				
LII[a]	CH_3	79	$C_{22}H_{34}O_4$ (362·5)	72·89 73·12	9·45 9·36
	7-Ethoxy derivatives ($R^1 = C_2H_5$)				
LIII[b]	H	60	$C_{22}H_{34}O_4$ (362·5)	72·89 72·58	9·45 9·27
LIV[c]	CH_3	76	$C_{23}H_{36}O_4$ (376·5)	73·36 73·04	9·63 9·48
LV[d]	CF_3	29	$C_{23}H_{33}F_3O_4$ (430·5)	64·16 64·34	7·72 7·48
LVI	C_2H_5	43	$C_{24}H_{38}O_4$ (390·5)	73·80 73·70	9·79 9·48
LVII[e]	$COCH_3$	26	$C_{24}H_{36}O_4$ (388·5)	74·19 74·49	9·34 9·06
LVIII	$(CH_2)_2CH_3$	57	$C_{25}H_{40}O_4$ (404·6)	74·21 74·46	9·96 9·85
LIX	$CH(CH_3)_2$	29	$C_{25}H_{40}O_4$ (404·6)	74·21 73·99	9·96 9·88
LX[f]		71	$C_{25}H_{38}O_4$ (402·6)	74·59 74·79	9·52 9·32
LXI[a]	$(CH_2)_2COOH$	70	$C_{25}H_{38}O_6$ (434·6)	69·09 69·03	8·81 8·94
LXII[h]	$(CH_2)_2COOCH_3$	96[i]	$C_{26}H_{40}O_6$ (448·6)	69·61 69·84	8·98 8·87
LXIII[j]	$(CH_2)_2COOC_2H_5$	43	$C_{27}H_{42}O_6$ (462·6)	70·09 69·81	9·15 9·40
LXIV	$(CH_2)_2COOC_3H_7$	27	$C_{28}H_{44}O_6$ (476·6)	70·55 70·38	9·30 9·27
LXV	$(CH_2)_2COOCH(CH_3)_2$	21	$C_{28}H_{44}O_6$ (476·6)	70·55 70·40	9·30 9·24

TABLE IV
(*Continued*)

No	R^2	Yield, %	Formula (mol.mass)	Calculated/ /Found	
				% C	% H
LXVI	$(CH_2)_2COO(CH_2)_3CH_3$	25	$C_{29}H_{46}O_4$ (490·6)	70·98 70·96	9·45 9·59
LXVII[k]	$(CH_2)_2COO(CH_2)_5CH_3$	20	$C_{31}H_{50}O_6$ (518·7)	71·78 71·95	9·72 9·77
LXVIII[l]	$(CH_2)_2COO(CH_2)_6CH_3$	10	$C_{32}H_{52}O_6$ (532·7)	72·14 71·98	9·84 10·12
LXIX[m]	$(CH_2)_2COOCH(CH_3)OC_2H_5$	20	$C_{29}H_{46}O_7$ (506·7)	68·74 68·83	9·15 9·10
LXX	$(CH_2)_3CH_3$	26	$C_{26}H_{42}O_4$ (418·6)	74·59 74·37	10·11 9·89
LXXI	$CH_2CH(CH_3)_2$	23	$C_{26}H_{42}O_4$ (418·6)	74·59 74·72	10·11 10·03
LXXII	$C(CH_3)_3$	20	$C_{26}H_{42}O_4$ (418·6)	74·59 74·88	10·11 10·06
LXXIII[n]	$CH{=}C(CH_3)_2$	21	$C_{26}H_{40}O_4$ (416·6)	74·96 74·91	9·68 9·96
LXXIV[o]	$CH_2C(=CH_2)COOH$	43	$C_{26}H_{38}O_6$ (446·6)	69·92 69·92	8·57 8·79
LXXV	$(CH_2)_4CH_3$	45	$C_{27}H_{43}O_4$ (431·6)	75·12 75·19	10·04 10·16
LXXVI	$(CH_2)_5CH_3$	44	$C_{28}H_{46}O_4$ (446·6)	75·28 75·37	10·38 10·18
LXXVII[p]	$CH_2C(CH_3)_2CH_2COOH$	20	$C_{28}H_{44}O_6$ (476·6)	70·55 70·33	9·30 9·24
LXXVIII[q]	C_6H_4-4-Cl	51	$C_{28}H_{37}ClO_4$ (473·0)	71·09 70·99	7·88 8·12
LXXIX	$(CH_2)_6CH_3$	30	$C_{29}H_{48}O_4$ (460·7)	75·60 75·43	10·50 10·33
LXXX[r]	C_6H_4-2-COOH	55	$C_{29}H_{38}O_6$ (482·6)	72·17 71·91	7·93 7·96
LXXXI[s]	C_6H_4-2-$COOCH_3$	96[i]	$C_{30}H_{40}O_6$ (496·6)	72·55 72·63	8·12 7·91

TABLE IV
(*Continued*)

No	R^2	Yield, %	Formula (mol.mass)	Calculated/ /Found % C	% H
LXXXII	$(CH_2)_7CH_3$	58	$C_{30}H_{50}O_4$ (474·7)	75·90 75·90	10·61 10·59
LXXXIII	$(CH_2)_8CH_3$	63	$C_{31}H_{52}O_4$ (488·6)	76·19 76·31	10·70 10·46
LXXXIV[t]	$(CH_2)_{10}CH_3$	23	$C_{33}H_{56}O_4$ (516·8)	76·69 76·56	10·92 10·71
LXXV	$(CH_2)_{12}CH_3$	35	$C_{35}H_{60}O_4$ (544·8)	77·15 77·11	11·09 10·76
LXXXVI	$(CH_2)_{14}CH_3$	62	$C_{37}H_{64}O_4$ (572·9)	77·56 77·71	11·26 11·16
LXXXVII	$(CH_2)_{16}CH_3$	65	$C_{39}H_{68}O_4$ (600·9)	77·94 77·98	11·40 11·33
LXXXVIII	$(CH_2)_7\overset{H}{\underset{|}{C}}=\overset{H}{\underset{|}{C}}(CH_2)_7CH_3$	44	$C_{39}H_{66}O_4$ (598·9)	78·20 77·94	11·10 10·90
LXXXIX	$(CH_2)_7\overset{H}{\underset{|}{C}}=\underset{|}{\overset{|}{C}}(CH_2)_7CH_3$ (H)	34	$C_{39}H_{66}O_4$ (598·9)	78·20 78·05	11·10 11·04
XC	$(CH_2)_7CH{=}CHCH_2CH{=}$ $={=}CH(CH_2)_4CH_3$	22	$C_{39}H_{64}O_4$ (596·9)	78·47 78·65	10·80 10·98
XCI	$(CH_2)_{18}CH_3$	10	$C_{41}H_{72}O_4$ (629·0)	78·29 78·58	11·54 11·53
XCII	$(CH_2)_{20}CH_3$	46	$C_{43}H_{76}O_4$ (657·0)	78·60 78·52	11·65 11·56
XCIII[u]	$CHCl_2$	35	$C_{25}H_{40}Cl_2O_5$ (491·5)	61·09 60·96	8·20 7·95
XCIV[u]	$(CH_2)_2CH_3$	80	$C_{27}H_{46}O_5$ (450·6)	71·96 72·19	10·29 9·92
XCV[u]	C_6H_5	31	$C_{30}H_{44}O_5$ (484·7)	74·34 74·50	9·15 9·36
XCVI[u]	C_6H_4-2-$COOCH_3$	96[i]	$C_{32}H_{42}O_7$ (538·7)	71·35 71·03	7·86 8·09

TABLE IV
(*Continued*)

No	R^2	Yield, %	Formula (mol.mass)	Calculated/Found % C	Calculated/Found % H
XCVII[u]	$(CH_2)_{16}CH_3$	80	$C_{41}H_{74}O_5$ (647·0)	76·10 76·43	11·53 11·73
	7-(2-Chloroethoxy)derivative (R^1 = CH_2CH_2Cl)				
XCVIII[v]	$(CH_2)_{10}CH_3$	30	$C_{33}H_{55}ClO_4$ (551·2)	71·90 71·80	10·06 10·13

[a] B.p. 172—174°C/13 Pa; [b] b.p. 169—170°C/13 Pa. IR spectrum (5%): 1728 (ν(CO)), 1671 (ν(C=C)), 1614, 1586, 1515 (ν arom.) cm^{-1}; [c] b.p. 175—177°C/13 Pa; [d] calculated: 13·28% F, found: 13·88% F; [e] IR spectrum (5%): 1728 (ν(CO)), 1686 (ν(CO) conj.) 1230 (ν(C—O)) cm^{-1}; [f] IR spectrum (4%): 3106, 3023 (νCH_2), 1729 (ν(CO)), 1672 (ν(C=C)), 1615, 1587, 1517 (ν arom.), 1384, 1365 ($\delta_s CH_3$) cm^{-1}. Mass spectrum: 402 (M^+), 387 ($C_{24}H_{33}O_4$), 374 ($C_{23}H_{32}O_4$), 356 ($C_{23}H_{32}O_3$), 288 ($C_{18}H_{24}O_3$), 220 ($C_{13}H_{16}O_3$), 191 ($C_{11}H_{11}O_3$), 135 ($C_9H_{11}O$), 121 ($C_7H_5O_2$), 87 ($C_5H_{11}O$), 69 (C_4H_5O); [g] IR spectrum (5%): 2600 (ν(OH) acid dimer), 1740 (ν(CO) est.), 1718 (ν(CO) acid dimer), 1671 (ν(C=C)), 1614, 1586, 1515 (ν arom.), 1236 (ν(C—O) est.) cm^{-1}; [h] IR spectrum (4%): 1744, 1731, (ν(CO), 1679 (ν C=C), 1614, 1587, 1521, 1515 (ν arom.), 1464, 1439 ($\delta_s OCH_3$), 1363, 1381 ($\delta_s CH_3$), 1238 (ν(C—O) est.) cm^{-1}; [i] Prepared on reaction of the acylation product with diazomethane; [j] mass spectrum: 317 ($C_{21}H_{33}O_2$), 280 ($C_{15}H_{20}O_5$), 251 ($C_{13}H_{15}O_5$), 135 ($C_9H_{11}O$), 129 ($C_6H_9O_3$), 87 ($C_5H_{11}O$). ^{1}H-NMR spectrum: δ(ppm): 0·85 (t, 3 H, J = 7·0), 1·13 (s, 6 H), 1·13 (t, 3 H, J = 7·0), 1·2 (t, 3 H, J = 7·0), 1·71 (s, 3 H), 1·40—2·2 (m, 8 H), 2·56 (s, 4 H), 3·32 (q, 2 H, J = 7·0), 4·08 (q, 2 H, J = 7·0), 4·50 (d, 2 H, J = 6·5), 5·48 (t, H, J = 6·5), 5·60 (t, H, J = 6·5), 6·83 (m, 2 H, J = 9·0), 7·23 (m, 2 H, J = 9·0); [k] IR spectrum (4%): 1741, 1730 (ν(CO)), 1671 (ν(C=C)), 1614, 1586, 1515 (ν arom.), 1381, 1363 ($\delta_s CH_3$) cm^{-1}; [l] mass spectrum: 350 ($C_{20}H_{30}O_5$), 317 ($C_{21}H_{33}O_2$), 199 ($C_{11}H_{19}O_3$), 135 ($C_9H_{11}O$), 87 ($C_5H_{11}O$); [m] IR spectrum (5%): 1742, 1731 (ν(CO) est.), 1615, 1588, 1518 (ν arom)., 1366, 1381 ($\delta_s CH_3$) cm^{-1}; [n] IR spectrum (3%): 1720 (ν(CO) conj.), 1654 (ν(C=C)), 1613, 1586, 1514 (ν arom)., 1387, 1381, 1363 ($\delta_s CH_3$) cm^{-1}. Mass spectrum: 416 (M^+), 316 ($C_{21}H_{32}O_2$), 301 ($C_{20}H_{29}O_2$), 286 ($C_{19}H_{26}O_2$), 257 ($C_{17}H_{21}O_2$), 234 ($C_{14}H_{18}O_3$), 205 ($C_{12}H_{13}O_3$), 183 ($C_{12}H_{23}O$), 135 ($C_9H_{10}O$), 87 ($C_5H_{11}O$); [o] IR spectrum (5%): 3621 (ν(OH)), 3534 (ν(OH)) acid monomer), 1741 (ν(CO) est.), 1711 (ν(CO) acid dimer), 1660 (ν(C=C)), 1614, 1586, 1516 (ν arom.), 1241 (ν(C—O) est.) cm^{-1}; [p] IR spectrum (3%): 2600—2700 (ν(OH) acid dimer), 1734 (ν(CO) est.), 1710 (νCO acid dimer), 1614, 1586, 1515 (ν arom.), 1236 (ν(C—O) est.) cm^{-1}; [q] IR spectrum (3%): 1723 (ν(CO) est. conj.), 1677 (ν(C=C)), 1614, 1597, 1588, 1515 (ν arom.), 1388, 1381, 1363 ($\delta_s CH_3$), 1270, (ν(C—O—C_6H_4)), 1238 (ν(C—O)) cm^{-1}. Mass spectrum: 472/4 (M^+), 362 ($C_{22}H_{34}O_4$), 290/2 ($C_{16}H_{15}ClO_3$), 261/3 ($C_{14}H_{10}ClO_3$), 183 ($C_{12}H_{23}O$), 156/8 ($C_7H_5ClO_2$), 151 ($C_9H_{11}O$), 139/41 (C_7H_4ClO), 135 ($C_9H_{11}O$), 87 ($C_5H_{11}O$); [r] IR spectrum (5%): 2550 (ν(OH)), 1728 (ν(CO) acid), 1711 (ν(CO) est.), 1614, 1599, 1584, 1515 (ν arom.) cm^{-1}; [s] mass spectrum: 496 (M^+), 314 ($C_{18}H_{18}O_5$), 163 ($C_9H_7O_3$), 87 ($C_5H_{11}O$); [t] IR spectrum (5%): 1737, 1731 (ν(CO)), 1677 (ν(C=C)), 1381, 1364 ($\delta_s CH_3$), 1237 (ν(C—O)) cm^{-1}; [u] 3,7-Diethoxyalkyl compound; [v] IR spectrum (5%): 1737, 1730 (ν(CO) est.), 1613, 1604, 1586, 1515 (ν arom.), 1381, 1365 ($\delta_s CH_3$), 1236 (ν(C—O) est.) cm^{-1}.

Compounds *XXXVIII*, *LI* and *LXIX*

p-Toluenesulfonic acid (a catalytic amount) was added under stirring and at room temperature to a solution of *XIII*, *XLIV* or *LXI* in an equimolar amount of 2,3-dihydro-4*H*-pyrane or ethyl vinyl ether and the mixture was stirred for 10 min. After dilution with water and extraction with diethyl ether the product was isolated and worked up as above. *XXXVIII*: b.p. 198—199°C/13 Pa; yield 92%. For $C_{24}H_{36}O_4$ (388·5) calculated: 74·19% C, 9·34% H; found: 74·08% C, 9·27% H. *LI*: yield 95%. For $C_{25}H_{42}O_4$ (406·6) calculated: 73·84% C, 10·41% H; found: 73·64% C, 10·35% H. IR spectrum (5%): 1667 (ν(C=C)), 1613, 1586 (ν arom.) cm^{-1}. Mass spectrum: 406 (M^+), 317 ($C_{21}H_{33}O_2$), 224 ($C_{13}H_{20}O_3$), 195 ($C_{11}H_{15}O_3$), 135 ($C_9H_{11}O$), 87 ($C_5H_{11}O$).

Compounds *XXXIX—XLI*, *LII—LXVIII*, *LXX—XCVIII* (ref.[3])

Chloride (or anhydride) of corresponding monocarboxylic acid (0·01 mol) was added gradually to a well stirred mixture of compound *XIII*, *XXVIII*, *XLIII—XLV* or *XLVIII* (0·01 mol) and pyridine (0·01 mol), and — if necessary — an addition of dimethylformamide, at room temperature. The mixture was allowed to stand at room temperature for 30 min if anhydride was used or overnight when acid chloride was employed. The isolation of the product was carried out as in the preceding experiments. In the case of compounds *LXI—LXVIII*, *LXXIV*, *LXXVII*, *LXXX*, *LXXXI* and *XCVI* the mixture of compound *XLIV* or *XLV* (0·01 mol), dicarboxylic acid anhydride (0·01 mol) and pyridine (0·01 mol) was heated at 60°C for 10 h and then allowed to stand at room temperature overnight. The product was isolated in the preceding manner. *XXXIX*: b.p. 182—185°C/13 Pa; yield 20%. For $C_{21}H_{30}O_4$ (346·5) calculated: 72·79% C, 8·72% H; found: 73·05% C, 8·73% H. Mass spectrum: 346 (M^+), 304 ($C_{19}H_{28}O_3$), 289 ($C_{19}H_{29}O_2$), 151 ($C_9H_{11}O_2$), 121 ($C_7H_5O_2$). *XL*: yield 14%. For $C_{23}H_{34}O_4$ (374·5) calculated: 73·76% C, 9·15% H; found: 73·89% C, 9·33% H. *XLI*: b.p. 221—223°C/13 Pa; yield 79%. For $C_{23}H_{34}O_5$ (390·5) calculated: 70·74% C, 8·77% H; found: 70·99% C, 8·81% H. Some data on compounds *LII—LXVIII*, *LXX—XCVIII* are given in Table IV.

Biological Activity

Biological activity expressed in ID-50 morphological units ranged between 500 and 0·0008 in *Tenebrio molitor* (*Coleoptera, Tenebrionidae*), between 1 000 and 0·1 in *Graphosoma italicum* (*Hemiptera, Pentatiomidae*), and between 1 000 and 0·05 in *Dysdercus cingulatus* (*Hemiptera, Pyrrhocoridae*). For a discussion of the structure-activity relationship see also ref.[4].

The elemental analyses were carried out by Mrs A. Froňková, E. Sýkorová, L. Pejchová, J. Konečná, Y. Černá and Dr J. Horáček; analyses by gas–liquid chromatography were carried out by Mr. J. Krahulec. The mass spectra were measured and interpreted by Dr J. Kohoutová and Dr K. Ubik; the IR *spectra were measured by Mrs K. Matoušková and Mr P. Formánek and interpreted by Dr P. Fiedler; the* ^{1}H-NMR *spectra were measured and interpreted by Dr M. Synáčková, Dr M. Masojídková and Dr M. Buděšínský. The biological tests were performed by Dr K. Sláma, Entomological Institute, Czechoslovak Academy of Sciences, Prague.*

REFERENCES

1. Kahovcová J., Romaňuk M.: Czech. Appl. PV 2866-80, 1980.
2. Kahovcová J., Romaňuk M., Sláma K.: Czech. Appl. PV 3596-80, 1980.
3. Kahovcová J., Romaňuk M., Sláma K.: Czech. 199 376 (1977).
4. Sláma K., Kahovcová J., Romaňuk M.: Pest. Biochem. Physiol. *8*, 313 (1978).

Translated by Ž. Procházka.