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Functionalyzed Nitrogen- and Phosphorus-containing Salts of Cycloalkanecarboxylic and Carboranecarboxylic Acids

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Abstract—A highly selective method for preparing potentially biologically active functionalyzed substituted nitrogen- and phosphorus-containing salts of maleopimaric, *o*(m)-carborane-1-carboxylic, D,L-camphoric, and *m*-carborane-1,7-dicarboxylic acids is developed.

The interest in functionalyzed nitrogen- and phosphorus-containing salts of carboxylic acids is caused by the broad range of their useful properties, such as a high biological [1–5] and adhesive activity [6–8].

The choice of maleopimaric **Ia**, *o*- and *m*-carborane-1-carboxylic (**Ib, Ic**), D,L-camphoric (1,2,2-trimethylcyclopentane-1,3-dicarboxylic) (**Id**), and *m*-carborane-1,7-dicarboxylic acids (**Id**) was motivated by the similarity of their spatial arrangement and the necessity of comparative study of the biological activity associated with pharmacophoric molecular fragments bound with the carboxy and amino groups.

Maleopimaric acid (**Ia**) is a dienic adduct prepared from levopimaric acid and maleic anhydride by the Diels–Alder reaction [9–11]. Acid **Ia** is a convenient and easily available synthon for preparing compounds possessing a broad-spectrum biological, specifically antiphlogistic, nematocide, and fungicide, activity [12–17], as well as monomers [18, 19]. The high biological activity of derivatives of maleopimaric acid (**Ia**) is explained by the stereochemical similarity of their 13α configuration to the A, B, and C rings of steroids [10, 20].

Boron compounds have first been applied for boron neutron capture therapy of cancer 1936 [21]. It is a binary radiotherapy that involves capture of heat neutrons by ^{10}B nuclei and their selective transfer to cancer cells. The neutron capture produces an excited ^{11}B nucleus that is then split to form two high-energy $^{4}He^{2+}$ and $^{7}Li^{3+}$ ions. These charged species create ionized tracks along their trajectories, thus causing cell decay [5, 22, 23]. One of the promising directions in the search for objects for preparing boron clusters for use in diagnostics and therapy of cancer is synthesis of carborane derivatives, including nitrogen- and phosphorus-containing [24–32].

The aim of this work was to develop a highly effective synthetic route to the potentially biologically active functionalyzed nitrogen- and phosphorus-containing salts of acids **Ia**–**Ie**. Previously unknown salts **IIIa**–**IIIt**, **IVa**–**IVi**, **Va**–**Vi**, and **VIIa**–**VIIi** were prepared by the reactions of acids **Ia**–**Ie** with aliphatic, aromatic, or heterocyclic amines and triphenylphosphine (**II**) (1 : 1 or 1 : 2 acid : **II** ratios with acids **Ia**–**Ic** and **Id, Ie**, respectively) in absolute chloroform (for **IIIa**–**IIIt, IVa**–**IVi, Va**–**Vi**) or methanol (for **VIa**–**VIi, VIIa**–**VIIi**). The reaction was complete within 10–15 min at 20–23°C. The yields of salts **IIIa**–**IIIt**, **IVa**–**IVi**, **Va**–**Vi**, and **VIIa**–**VIIi** were 89–96%.

The resulting salts are colorless or slightly colored brittle crystalline substances. They are readily soluble in acetone and C_1–C_4 alcohols and poorly soluble in water. All the salts are nonhygroscopic and withstand handling in sealed ampules at 0–5°C in the dark.

The structures of acids **Ia**–**Ie** and salts **IIIa**–**IIIt**, **Va**–**Vi**, **VIa**–**VIi**, and **VIIa**–**VIIi** were confirmed by their elemental analyses and ^{1}H NMR, IR, and UV spectra (Tables 1–3) [33, 34].

Thermal stability of peroxy derivatives **VIg** and **VIIg** was assessed by means of thermal analysis. Analysis of the DTG, TG, and DTA curves show that peroxides **VIg** and **VIg** are fairly thermally stable compounds. Peroxide **VIh** derived from D,L-camphoric acid (**Id**) and a peroxy-containing amine begins to decompose at an appreciable and a well-defined heat release at 142°C (first stage of decomposition: 142–212°C, maximum 182°C, weight loss 24.5%). Compound **VIIg** derived from *m*-carborane-1,7-di-

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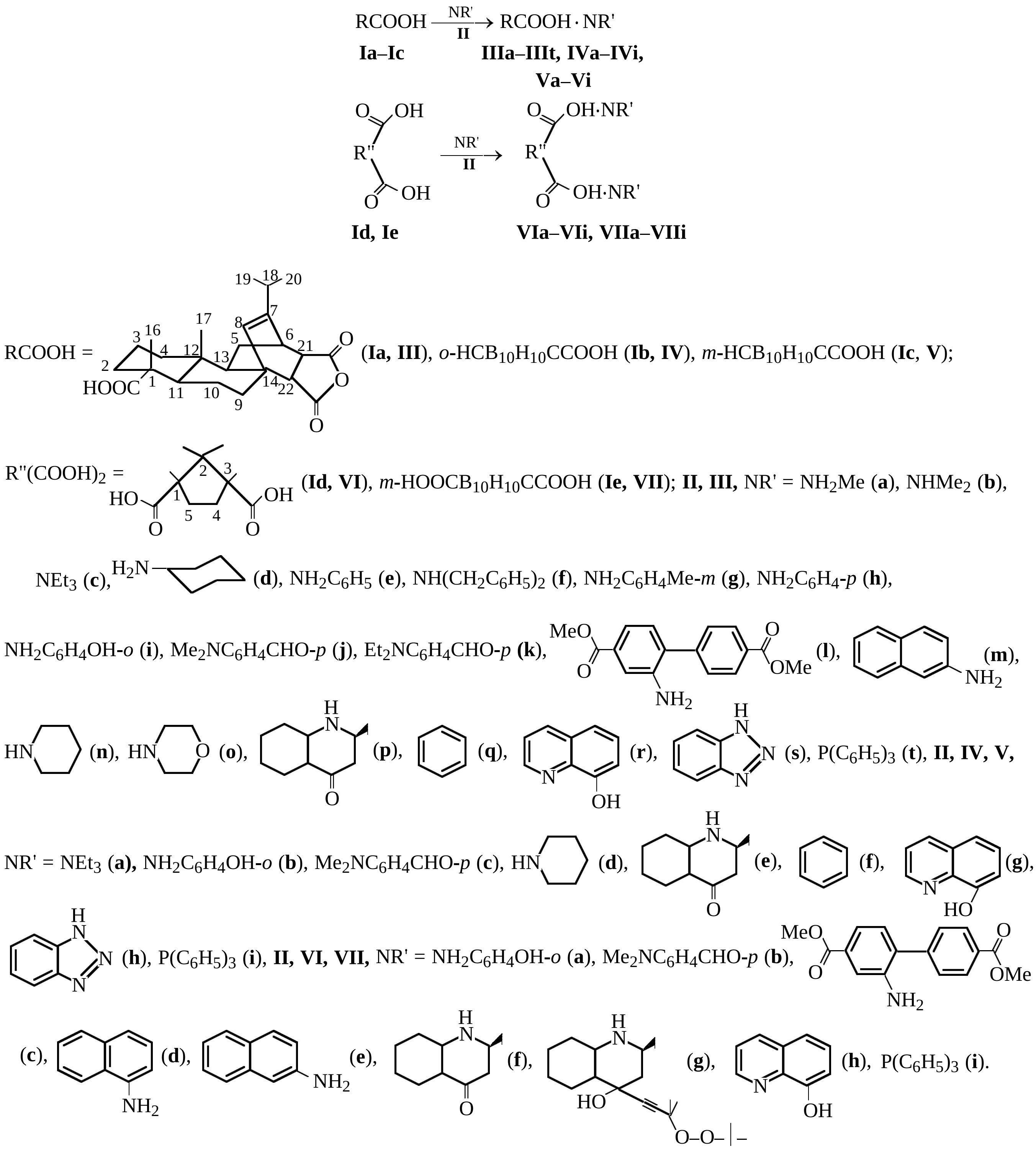

carboxylic acid (**Id**) is slightly more stable thermally than peroxide **VIg** and decomposes at 150°C (first stage of decomposition: 150–205°C, maximum 185°C, weight loss 38.5%).

The purity of the products was 99 ± 1% (NMR data) [33].

EXPERIMENTAL

The IR spectra were recorded on a Protege-460 Fourier spectrometer in KBr pellets. The ^{1}H NMR spectra were measured on a Tesla 567A spectrometer (100 MHz) in $CDCl_3$ (**Ia**–**Ic**, **IIIa**–**IIIt**, **IVa**, **IVc**, **IVd**, **IVf**, **IVh**, **Va**, **Vc**–**Vf**, **Vh**, and **Vi**) or $(CD_3)_2CO$ (**Id,**

Table 1. Properties of compounds **Ia–Ie, IIIa–IIIt, IVa–IVi, Va–Vi, VIa–VIi**, and **VIIa–VIIi**

Comp. no.	Yield, %	mp, °C (decomp.)	Found, %				Formula	Calculated, %				M_{calc}
			C	H	B (Br)	N (P)		C	H	B (Br)	N (P)	
Ia	–	225	72.16	7.91	–	–	$C_{24}H_{32}O_5$	71.97	8.05	–	–	400.5
Ib	–	150	19.35	6.56	57.21	–	$C_3H_{12}B_{10}O_2$	19.14	6.43	57.43	–	188.2
Ic	–	163	19.40	6.54	57.30	–	$C_3H_{12}B_{10}O_2$	19.14	6.43	57.43	–	188.2
Id	–	185	60.38	8.18	–	–	$C_{10}H_{16}O_4$	59.98	8.05	–	–	200.2
Ie	–	203	20.87	5.32	46.16	–	$C_4H_{12}B_{10}O_4$	20.69	5.21	46.55	–	232.3
IIIa	96	67	69.74	8.77	–	3.16	$C_{25}H_{37}NO_5$	69.58	8.64	–	3.25	431.6
IIIb	90	130	70.29	9.01	–	2.99	$C_{26}H_{39}NO_5$	70.08	8.82	–	3.14	445.6
IIIc	95	86	72.04	9.56	–	2.64	$C_{30}H_{47}NO_5$	71.82	9.44	–	2.79	501.7
IIId	92	158	72.35	9.22	–	2.64	$C_{30}H_{45}NO_5$	72.11	9.08	–	2.80	499.7
IIIe	93	63	73.12	8.14	–	2.65	$C_{30}H_{39}NO_5$	72.99	7.96	–	2.84	493.6
IIIf	95	59	76.51	8.05	–	2.19	$C_{38}H_{47}NO_5$	76.35	7.92	–	2.34	597.8
IIIg	90	64	73.52	8.25	–	2.50	$C_{31}H_{41}NO_5$	73.34	8.14	–	2.76	507.7
IIIh	92	56	63.11	6.84	13.80	2.22	$C_{30}H_{38}BrNO_5$	62.94	6.69	13.96	2.45	572.5
IIIi	91	116	71.03	7.94	–	2.56	$C_{30}H_{39}NO_6$	70.70	7.71	–	2.75	509.6
IIIj	94	36	72.34	8.03	–	2.27	$C_{33}H_{43}NO_6$	72.10	7.88	–	2.55	549.7
IIIk	93	31	72.90	8.32	–	2.19	$C_{35}H_{47}NO_6$	72.76	8.20	–	2.42	577.8
IIIl	94	157	70.33	7.11	–	1.96	$C_{40}H_{47}NO_9$	70.05	6.91	–	2.04	685.8
IIIm	96	75	75.40	7.73	–	2.32	$C_{34}H_{41}NO_5$	75.11	7.60	–	2.58	543.7
IIIn	91	77	71.88	9.04	–	2.60	$C_{29}H_{43}NO_5$	71.72	8.92	–	2.88	485.7
IIIo	92	146	69.19	8.74	–	2.56	$C_{28}H_{41}NO_6$	68.97	8.47	–	2.87	487.6
IIIp	95	57	72.13	8.91	–	2.31	$C_{34}H_{49}NO_6$	71.93	8.70	–	2.47	567.8
IIIq	94	118	72.71	7.84	–	2.80	$C_{29}H_{37}NO_5$	72.62	7.78	–	2.92	479.6
IIIr	94	47	72.73	7.34	–	2.40	$C_{33}H_{39}NO_6$	72.64	7.20	–	2.57	545.7
IIIs	91	68	69.61	7.34	–	7.91	$C_{30}H_{37}N_3O_5$	69.34	7.18	–	8.09	519.6
IIIt	96	47	76.29	7.25	–	4.60	$C_{42}H_{47}PO_5$	76.11	7.15	–	4.67	662.8
IVa	89	86	37.59	9.57	37.51	4.50	$C_9H_{27}B_{10}NO_2$	37.35	9.40	37.35	4.84	289.4
IVb	97	204	36.49	6.52	36.11	4.41	$C_9H_{19}B_{10}NO_3$	36.35	6.44	36.36	4.71	297.4
IVc	95	104	42.82	6.92	31.91	4.08	$C_{12}H_{23}B_{10}NO_3$	42.71	6.87	32.04	4.15	337.4
IVd	93	197	35.29	8.73	39.39	5.01	$C_8H_{23}B_{10}NO_2$	35.15	8.48	39.55	5.12	273.4
IVe	94	185	44.11	8.34	30.28	3.80	$C_{13}H_{29}B_{10}NO_3$	43.92	8.22	30.41	3.94	355.5
IVf	94	156	36.07	6.54	40.19	5.08	$C_8H_{17}B_{10}NO_2$	35.94	6.41	40.44	5.24	276.3
IVg	93	167	43.52	5.83	32.22	4.07	$C_{12}H_{19}B_{10}NO_3$	43.23	5.74	32.43	4.20	333.4
IVh	90	107	35.51	5.72	35.01	13.21	$C_9H_{17}B_{10}N_3O_2$	35.17	5.57	35.17	13.67	307.4
IVi	91	54	56.12	6.15	30.48		$C_{21}H_{27}B_{10}PO_2$	55.99	6.04	24.00	6.87	450.5
Va	95	103	37.61	9.55	37.20	4.60	$C_9H_{27}B_{10}NO_2$	37.35	9.40	37.35	4.84	289.4
Vb	96	187	36.47	6.56	36.20	4.55	$C_9H_{19}B_{10}NO_3$	36.35	6.44	36.36	4.71	297.4
Vc	94	103	42.93	7.02	31.88	4.01	$C_{12}H_{23}B_{10}NO_3$	42.71	6.87	32.04	4.15	337.4
Vd	96	201	35.32	8.65	39.37	5.10	$C_8H_{23}B_{10}NO_2$	35.15	8.48	39.55	5.12	273.4
Ve	92	112	44.19	8.35	30.12	3.70	$C_{13}H_{29}B_{10}NO_3$	43.92	8.22	30.41	3.94	355.5
Vf	93	161	36.12	6.56	40.21	5.10	$C_8H_{17}B_{10}NO_2$	35.94	6.41	40.44	5.24	276.3
Vg	95	131	43.44	5.91	33.22	4.06	$C_{12}H_{19}B_{10}NO_3$	43.23	5.74	32.43	4.20	333.4
Vh	95	84	35.41	5.65	34.98	13.25	$C_9H_{17}B_{10}N_3O_2$	35.17	5.57	35.17	13.67	307.4
Vi	92	53	56.20	6.27	30.39		$C_{21}H_{27}B_{10}PO_2$	55.99	6.04	24.00	6.87	450.5
VIa	95	153	63.36	7.41	–	6.48	$C_{22}H_{30}N_2O_6$	63.14	7.23	–	6.69	418.5
VIb	94	58	67.62	7.93	–	5.39	$C_{28}H_{38}N_2O_6$	67.45	7.68	–	5.62	498.6
VIc	94	157	65.63	6.18	–	3.30	$C_{42}H_{46}N_2O_{12}$	65.44	6.01	–	3.63	770.8
VId	93	39	74.28	7.17	–	5.38	$C_{30}H_{34}N_2O_4$	74.05	7.04	–	5.76	486.6
VIe	96	103	74.31	7.25	–	5.41	$C_{30}H_{34}N_2O_4$	74.05	7.04	–	5.76	486.6

Table 1. (Contd.)

Comp. no.	Yield, %	mp, °C (decomp.)	Found, %				Formula	Calculated, %				M_{calc}
			C	H	B (Br)	N (P)		C	H	B (Br)	N (P)	
VIf	94	42	67.62	9.63	–	5.22	$C_{30}H_{50}N_2O_6$	67.38	9.42	–	5.24	534.7
VIg	92	83	68.29	10.03	–	3.18	$C_{48}H_{82}N_2O_{10}$	68.05	9.76	–	3.31	847.2
VIh	94	69	68.90	6.31	–	5.44	$C_{28}H_{30}N_2O_6$	68.56	6.16	–	5.71	490.6
VIi	94	64	76.20	6.51	–	8.39	$C_{46}H_{46}P_2O_4$	76.23	6.40	–	8.55	724.8
VIIa	96	206	42.84	6.01	23.89	5.98	$C_{16}H_{26}B_{10}N_2O_6$	42.66	5.82	24.00	6.22	450.5
VIIb	92	108	50.11	6.58	20.09	5.11	$C_{22}H_{34}B_{10}N_2O_6$	49.80	6.46	20.37	5.28	530.6
VIIc	95	138	54.06	5.42	13.10	3.25	$C_{36}H_{42}B_{10}N_2O_{12}$	53.86	5.27	13.47	3.49	802.8
VIId	94	84	55.81	6.02	20.63	5.18	$C_{24}H_{30}B_{10}N_2O_4$	55.58	5.83	20.85	5.40	518.6
VIIe	95	105	55.77	5.96	20.73	5.19	$C_{24}H_{30}B_{10}N_2O_4$	55.58	5.83	20.85	5.40	518.6
VIIf	96	198	51.09	8.31	18.89	4.87	$C_{24}H_{46}B_{10}N_2O_6$	50.86	8.18	19.08	4.94	566.8
VIIg	93	106	57.52	9.10	12.09	2.99	$C_{42}H_{78}B_{10}N_2O_{10}$	57.38	8.94	12.30	3.19	879.2
VIIh	96	71	50.74	5.13	20.48	5.17	$C_{22}H_{26}B_{10}N_2O_6$	50.57	5.01	20.69	5.36	522.6
VIIi	93	63	63.81	5.71	22.20		$C_{40}H_{42}B_{10}P_2O_4$	63.48	5.59	14.29	8.19	756.8

Table 2. ^{1}H NMR spectra of compounds **Ia–Ie, IIIa–IIIt, IVa–IVi, Va–Vi, VIa–VIi**, and **VIIa–VIIi**

Comp. no.	δ, ppm
Ia	0.57 s (3H, $C^{12}Me$), 0.97 d (6H, Me_2C), 1.14 s (3H, C^1Me), 0.80–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.49 s (1H, C=CH), 5.50–6.90 br.s (1H, COOH)
Ib	–1.80–7.00 m (10H, $B_{10}H_{10}$), 4.05 s (1H, CH), 10.22 s (1H, COOH)
Ic	–1.45–6.80 m (10H, $B_{10}H_{10}$), 3.04 s (1H, CH), 8.98 s (1H, COOH)
Id	0.89 s (3H, Me), 1.25 s and 1.32 s (6H, Me2), 1.40–3.10 m [5H, CH and $(CH_2)_2$], 10.15 br.s (2H, 2COOH)
Ie	–1.50–8.00 m (10H, $B_{10}H_{10}$), 7.00 br.s (2H, 2COOH)
IIIa	0.56 s (3H, $C^{12}Me$), 0.96 d (6H, Me_2C), 1.11 s (3H, C^1Me), 0.80–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 2.52 s (3H, MeN), 5.48 s (1H, C=CH), 8.55–9.05 br.s (3H, NH_3)
IIIb	0.57 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.09 s (3H, C^1Me), 0.75–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 2.50 s (6H, Me_2N), 5.46 s (1H, C=CH), 9.18 br.s (2H, NH_2)
IIIc	0.56 s (3H, $C^{12}Me$), 0.96 d (6H, Me_2C), 1.05 t (9H, 3*Me*CH_2), 1.10 s (3H, C^1Me), 0.70–3.05 m [24H, 6CH, $4CH_2$, $(CH_2)_2$ and $(CH_2)_3$], 5.46 s (1H, C=CH), 10.28 br.s (1H, NH)
IIId	0.57 s (3H, $C^{12}Me$), 1.02 d (6H, Me_2C), 1.20 s (3H, C^1Me), 0.75–3.20 m [29H, 7CH, CH_2, $(CH_2)_2$, $(CH_2)_3$ and $(CH_2)_5$], 5.47 s (1H, C=CH), 7.00–8.50 br.s (3H, NH_3)
IIIe	0.56 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.12 s (3H, C^1Me), 0.80–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 6.00 br.s (3H, NH_3), 6.50–7.35 m (5H, C_6H_5)
IIIf	0.55 s (3H, $C^{12}Me$), 0.94 d (6H, Me_2C), 1.10 s (3H, C^1Me), 0.85–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 3.84 s [4H, $N(CH_2)_2$], 5.48 s (1H, C=CH), 6.80–7.90 br.s (2H, NH_2), 7.10–7.40 m (10H, $2C_6H_5$)
IIIg	0.56 s (3H, $C^{12}Me$), 0.94 d (6H, Me_2C), 1.13 s (3H, C^1Me), 0.80–3.25 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 2.22 s (3H, *Me*C_6H_4), 5.34 br.s (3H, NH_3), 5.49 s (1H, C=CH), 6.30–7.10 m (4H, C_6H_4)
IIIh	0.56 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.13 s (3H, C^1Me), 0.75–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.05 br.s (3H, NH_3), 5.48 s (1H, C=CH), 6.30–7.40 m (4H, C_6H_4)
IIIi	0.56 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.13 s (3H, C^1Me), 0.75–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 0.48 s (1H, C=CH), 6.40–7.70 m (4H, NH_3 and OH), 6.95–7.40 m (4H, C_6H_4)
IIIj	0.57 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.14 s (3H, C^1Me), 0.75–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 3.04 s (6H, Me2N), 5.48 s (1H, C=CH), 6.45–7.85 m (4H, C_6H_4), 9.69 s (1H, CHO)
IIIk	0.57 s (3H, $C^{12}Me$), 0.96 s (6H, Me_2C), 1.14 s (3H, C^1Me), 1.17 t (6H, 2*Me*CH_2), 0.70–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 3.42 q [4H, $N(CH_2)_2$], 5.48 s (1H, C=CH), 6.45–7.85 m (4H, C_6H_4), 9.65 s (1H, CHO)

Table 2. (Contd.)

Comp. no.	δ, ppm
IIIl	0.57 s (3H, $C^{12}Me$), 0.96 d (6H, Me_2C), 1.14 s (3H, C^1Me), 0.80–3.15 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 3.87 s and 3.91 s (6H, 2COOMe), 5.48 s (1H, C=CH), 6.95–8.20 m (10H, C_6H_4, C6H3 and NH_3)
IIIm	0.55 s (3H, $C^{12}Me$), 0.94 d (6H, Me_2), 1.13 s (3H, C^1Me), 0.75–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 5.75 br.s (3H, NH_3), 6.75–7.80 m (7H, $C_{10}H_7$)
IIIn	0.55 s (3H, $C^{12}Me$), 0.96 d (6H, Me_2C), 1.07 s (3H, C^1Me), 0.70–3.75 m [28H, 6CH, CH_2, $(CH_2)_2$, $(CH_2)_3$ and $(CH_2)_5$], 5.48 s (1H, C=CH), 7.40–8.50 m (2H, NH_2)
IIIo	0.56 s (3H, $C^{12}Me$), 0.96 d (6H, Me_2C), 1.10 s (3H, C^1Me), 0.70–4.00 m [26H, 6CH, CH_2, $3(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 8.35 br.s (2H, NH_2)
IIIp	0.56 s (3H, $C^{12}Me$), 0.97 d (6H, Me_2C), 1.11 s (3H, C^1Me), 1.22 d (3H, *Me*CH), 0.70–3.30 m [31H, 9CH, $2CH_2$, $(CH_2)_2$, $(CH_2)_3$ and $(CH_2)_4$], 5.48 s (1H, C=CH), 5.75–7.00 br.s (2H, NH_2)
IIIq	0.57 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.15 s (3H, C^1Me), 0.75–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 7.15–8.85 m (5H, C5H5N), 10.17 br.s (1H, NH)
IIIr	0.57 s (3H, $C^{12}Me$), 0.95 d (6H, Me_2C), 1.14 s (3H, C^1Me), 0.75–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 7.05–8.85 m (8H, C9H6N, NH and OH)
IIIs	0.57 s (3H, $C^{12}Me$), 0.94 d (6H, Me_2C), 1.15 s (3H, C^1Me), 0.75–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 7.20–8.00 m (4H, C_6H_4), 7.70–9.00 br.s (2H, NH_2)
IIIt	0.56 s (3H, $C^{12}Me$), 0.96 d (6H, Me_2C), 1.13 s (3H, C^1Me), 0.75–3.20 m [18H, 6CH, CH_2, $(CH_2)_2$ and $(CH_2)_3$], 5.48 s (1H, C=CH), 7.00–7.50 m (15H, $3C_6H_5$), 7.65 br.s (1H, PH)
IVa	–1.40–5.80 m (10H, $B_{10}H_{10}$), 1.29 t (9H, 3Me), 3.06 q (6H, $3CH_2$), 4.10 s (1H, CH), 10.30 br.s (1H, NH)
IVb	–1.40–5.80 m (10H, $B_{10}H_{10}$), 4.45 s (1H, CH), 6.35–7.15 m (4H, C_6H_4)
IVc	–1.50–6.20 m (10H, $B_{10}H_{10}$), 3.13 s (6H, Me_2N), 4.10 s (1H, CH), 6.65–7.95 m (4H, C_6H_4), 9.55 s (1H, CHO), 10.74 s (1H, NH)
IVd	–1.80–6.20 m (10H, $B_{10}H_{10}$), 1.45–3.15 m [10H, $(CH_2)_5$], 4.08 s (1H, CH), 7.55 br.s (2H, NH_2)
IVe	–1.60–6.50 m (10H, $B_{10}H_{10}$), 1.00–4.60 m [14H, 4CH, CH_2 and $(CH_2)_4$], 1.42 d (3H, Me)
IVf	–1.60–6.20 m (10H, $B_{10}H_{10}$), 4.17 s (1H, CH), 7.70–9.12 m (5H, C_5H_5N), 17.03 s (1H, NH)
IVg	–1.70–6.20 m (10H, $B_{10}H_{10}$), 4.50 s (1H, CH), 7.20–9.01 m (6H, C_9H_6N)
IVh	–1.50–5.90 m (10H, $B_{10}H_{10}$), 4.15 s (1H, CH), 7.15–8.10 m (4H, C_6H_4), 13.58 s (2H, NH_2)
IVi	–1.40–5.80 m (10H, $B_{10}H_{10}$), 3.95 s (1H, CH), 7.00–7.70 m (15H, $3C_6H_5$), 10.30 s (1H, PH)
Va	–1.40–5.80 m (10H, $B_{10}H_{10}$), 1.26 t (9H, 3Me), 3.00 s (1H, CH), 3.05 q (6H, $3CH_2$), 12.60 br.s (1H, NH)
Vb	–1.40–6.00 m (10H, $B_{10}H_{10}$), 3.65 s (1H, CH), 6.45–7.30 m (4H, C_6H_4)
Vc	–1.35–5.80 m (10H, $B_{10}H_{10}$), 3.01 s (1H, CH), 3.11 s (6H, Me_2N), 6.55–7.80 m (4H, C_6H_4), 9.20 s (1H, NH), 9.64 s (1H, CHO)
Vd	–1.40–6.40 m (10H, $B_{10}H_{10}$), 1.40–3.40 m [11H, CH and $(CH_2)_5$], 9.05 br.s (2H, NH_2)
Ve	–1.40–5.90 m (10H, $B_{10}H_{10}$), 1.00–3.65 m [14H, 4CH, CH_2 and $(CH_2)_4$], 1.31 d (3H, Me), 8.65 br.s (2H, NH_2)
Vf	–1.40–5.80 m (10H, $B_{10}H_{10}$), 2.98 s (1H, CH), 7.50–8.80 m (5H, C_5H_5N), 11.57 s (1H, NH)
Vg	–1.60–6.80 m (10H, $B_{10}H_{10}$), 3.78 s (1H, CH), 7.00–8.95 m (6H, C_9H_6N)
Vh	–1.40–6.80 m (10H, $B_{10}H_{10}$), 3.04 s (1H, CH), 7.10–8.10 m (4H, C_6H_4), 12.85 s (2H, NH_2)
Vi	–1.40–6.80 m (10H, $B_{10}H_{10}$), 2.95 s (1H, CH), 7.15–7.40 m (15H, $3C_6H_5$), 9.55 s (1H, PH)
VIa	0.89 s (3H, Me), 1.25 s and 1.32 s (6H, Me_2C), 1.40–3.10 m [5H, CH and $(CH_2)_2$], 5.80 br.s (2H, 2OH), 6.30–7.00 m (14H, $2NH_3$ and $2C_6H_4$)
VIb	0.89 s (3H, Me), 1.25 s and 1.32 s (6H, Me_2C), 1.40–3.10 m [5H, CH and $(CH_2)_2$], 3.09 s (12H, $2Me_2N$), 6.70–7.90 m (8H, $2C_6H_4$), 9.73 s (2H, 2CHO)
VIc	0.89 s (3H, Me), 1.25 s and 1.32 s (6H, Me_2C), 1.30–3.00 m [5H, CH and $(CH_2)_2$], 3.86 s and 3.92 s (12H, 4COOMe), 7.05–8.10 m (20H, $2NH_3$, $2C_6H_4$ and $2C_6H_3$)
VId	0.89 s (3H, Me), 1.25 s and 1.32 s (6H, Me_2C), 1.20–3.00 m [5H, CH and $(CH_2)_2$], 6.25 br.s (6H, $2NH_3$), 6.65–8.05 m (14H, $2C_{10}H_7$)
VIe	0.90 s (3H, Me), 1.25 s and 1.33 s (6H, Me_2C), 1.40–3.05 m [5H, CH and $(CH_2)_2$], 6.50 br.s (6H, $2NH_3$), 6.85–8.00 m (14H, $2C_{10}H_7$)

Table 2. (Contd.)

Comp. no.	δ, ppm
VIf	0.94 s (3H, Me), 1.24 s, 1.26 d, 1.32 s (12H, 2Me and Me_2C), 1.05–3.30 m [31H, 7CH, $2CH_2$, $(CH_2)_2$ and $2(CH_2)_4$], 6.08 br.s (4H, $2NH_2$)
VIg	0.94 s (3H, Me), 1.10–1.25 m (30H, 2Me, Me_2C and $2Me_3COO$), 1.46 s and 1.54 s (12H, $2Me_2CC≡C$), 1.05–3.00 m [31H, 7CH, $2CH_2$, $(CH_2)_2$ and $2(CH_2)_4$], 5.89 br.s (6H, 2OH and $2NH_2$)
VIh	0.90 s (3H, Me), 1.25 s and 1.33 s (6H, Me_2C), 1.30–3.00 m [5H, CH and $(CH_2)_2$], 7.00–8.85 m (12H, $2C_9H_6N$), 9.15 br.s (4H, 2OH and 2NH)
VIi	0.89 s (3H, Me), 1.25 s and 1.33 s (6H, Me_2C), 1.35–3.00 m [5H, CH and $(CH_2)_2$], 7.05–7.85 m (30H, $6C_6H_5$), 8.50 br.s (2H, 2PH)
VIIa	–1.40–6.00 m (10H, $B_{10}H_{10}$), 6.20–7.30 m (18H, 2OH, $2NH_3$ and $2C_6H_4$)
VIIb	–1.40–6.10 m (10H, $B_{10}H_{10}$), 3.09 s (12H, $2Me_2N$), 6.65–7.80 m (8H, $2C_6H_4$), 9.72 s (2H, 2CHO), 9.82 br.s (2H, 2NH)
VIIc	–1.40–6.40 m (10H, $B_{10}H_{10}$), 3.92 s and 3.96 s (12H, 4COOMe), 7.10–8.20 m (20H, $2NH_3$, $2C_6H_4$ and $2C_6H_3$)
VIId	–1.40–6.40 m (10H, $B_{10}H_{10}$), 6.50–8.15 m (20H, $2NH_3$ and $2C_{10}H_7$)
VIIe	–1.40–6.40 m (10H, $B_{10}H_{10}$), 6.80–8.20 m (20H, $2NH_3$ and $2C_{10}H_7$)
VIIf	–1.40–6.00 m (10H, $B_{10}H_{10}$), 0.80–3.30 m [26H, 6CH, $2CH_2$ and $2(CH_2)_4$], 1.17 d (6H, 2Me), 7.15 br.s (4H, $2NH_2$)
VIIg	–1.40–6.00 m (10H, $B_{10}H_{10}$), 0.70–3.70 m [28H, 2OH, 6CH, $2CH_2$ and $2(CH_2)_4$], 1.17 br.s (24H, 2Me and $_2Me_3COO$), 1.46 br.s (12H, $2Me_2CC≡C$), 7.20 br.s (4H, $2NH_2$)
VIIh	–1.40–6.00 m (10H, $B_{10}H_{10}$), 7.00–9.00 m (16H, 2OH, 2NH and $2C_9H_6N$)
VIIi	–1.40–6.40 m (10H, $B_{10}H_{10}$), 6.80–7.90 m (30H, $6C_6H_5$), 8.70 br.s (2H, 2PH)

Table 3. IR and UV spectra of **Ia–Ie, IIIa–IIIt, IVa–IVi, Va–Vi, VIa–VIi**, and **VIIa–VIIi**

Comp. no.	IR spectrum, ν, cm^{-1}	UV spectrum, $λ_{max}$, nm (ε)
Ia	3700–2400 (OH); 3040 (=CH); 2975, 2957, 2934, 2872 (CH_{Alk}); 1830, 1759, 1716 (C=O); 1634 (C=C); 1468, 1445 (CH_2); 1238, 1222, 1091, 950, 929 (C–O)	203 (3000)
Ib	2200–3600 (OH); 3080 (CH_{carb}); 2630, 2612, 2590, 2572, 2558 (BH); 1724 (C=O); 1428, 1280 (C–O); 897 (CH_{carb}); 732, 712, 704 (BH)	204 (200)
Ic	2100–3650 (OH); 3066 (CH_{carb}); 2618 (BH); 1712 (C=O); 1421, 1289 (C–O); 925 (CH_{carb}); 734, 719 (BH)	204 (200), 220 (150)
Id	3650–2300 (OH); 2980, 2974, 2890 (CH_{Alk}); 1710, 1698 (C=O); 1475, 1459 (CH_2); 1281, 1246, 1168, 1125 (C–O)	215 (200)
Ie	3750–2200 (OH); 2670, 2626, 2695, 2585, 2531 (BH); 1720 (C=O); 1440, 1417, 1275 (C–O); 915, 843, 723 (BH)	203 (150), 220 (50)
IIIa	3045 (=CH); 2985, 2935, 2869 (CH_{Alk}); 1824, 1779, 1704 (C=O); 1640 (C=C); 1466 (CH_2); 1231, 1087, 947, 923 (C–O)	204 (6000)
IIIb	3045 (=CH); 2955, 2934, 2867 (CH_{Alk}); 1860, 1840, 1781, 1710 (C=O); 1635 (C=C); 1468 (CH_2); 1232, 1080, 1040, 947, 924 (C–O)	204 (6000)
IIIc	3040 (=CH); 2957, 2937, 2869 (CH_{Alk}); 1842, 1780, 1707 (C=O); 1640 (C=C); 1467 (CH_2); 1231, 1086, 947, 923 (C–O)	204 (6000)
IIId	3386 (NH); 3040 (=CH); 2933, 2861 (CH_{Alk}); 1857, 1843, 1782, 1696 (C=O); 1635 (C=C); 1466, 1451 (CH_2); 1231, 1086, 947, 923 (C–O)	207 (6000)
IIIe	3382 (NH); 3075, 3040, 3010 (=CH and CH_{Ar}); 2956, 2933, 2869 (CH_{Alk}); 1843, 1779, 1693 (C=O); 1630 (C=C); 1602, 1499 (Ar); 1467, 1443 (CH_2); 1277, 1231, 1086, 947, 923 (C–O); 794, 752, 692 (CH_{Ar})	207 (12000), 238 (7000), 288 (1000)

Table 3. (Contd.)

Comp. no.	IR spectrum, ν, cm^{-1}	UV spectrum, λ_{max}, nm (ε)
IIIf	3090, 3063, 3031 (=CH and CH_{Ar}); 2956, 2931, 2867 (CH_{Alk}); 1855, 1842, 1779, 1696 (C=O); 1637 (C=C); 1605, 1497 (Ar); 1456 (CH_2); 1230, 1208, 1084, 947, 923 (C–O); 751, 698 (CH_{Ar})	210 (21000)
IIIg	3377 (NH); 3080, 3040, 3015 (=CH and CH_{Ar}); 2956, 2931, 2868 (CH_{Alk}); 1855, 1824, 1779, 1693 (C=O); 1630 (C=C); 1613, 1594, 1541, 1492 (Ar); 1466, 1447 (CH_2); 1230, 1086, 947, 923 (C–O); 776, 757, 691 (CH_{Ar})	208 (19000), 242 (8000)
IIIh	3381 (NH); 3060, 3040, 3005 (=CH and CH_{Ar}); 2956, 2932, 2868 (CH_{Alk}); 1842, 1778, 1692 (C=O); 1625 (C=C); 1594, 1524, 1489 (Ar); 1466, 1446 (CH_2); 1280, 1231, 1085, 947, 923 (C–O); 821, 756, 674 (CH_{Ar})	207 (23000), 248 (13000)
IIIi	3375 (NH); 3303 (OH); 3065, 3040, 3025 (=CH and CH_{Ar}); 2957, 2937, 2870 (CH_{Alk}); 1855, 1843, 1779, 1693 (C=O); 1640 (C=C); 1599, 1512, 1500 (Ar); 1461 (CH_2); 1280, 1228, 1085, 948, 924 (C–O); 755 (CH_{Ar})	207 (19000), 235 (6000), 285 (3000)
IIIj	3065, 3040, 3025 (=CH and CH_{Ar}); 2960, 2932, 2868, 2825, 2739 (CH_{Alk}); 1855, 1842, 1779, 1716, 1691, 1660 (C=O); 1640 (C=C); 1596, 1552, 1534, 1373 (Ar); 1465, 1440 (CH_2); 1230, 1166, 1084, 1001, 946, 921, 905 (C–O); 815, 753, 728, 693, 670, 595 (CH_{Ar})	204 (11000), 240 (4000), 350 (13000)
IIIk	3065, 3040, 3025 (=CH and CH_{Ar}); 2975, 2957, 2933, 2869, 2816, 2795, 2752 (CH_{Alk}); 1856, 1845, 1779, 1704 (C=O); 1637 (C=C); 1586, 1546, 1528, 1351 (Ar); 1458, 1444 (CH_2); 1230, 1192, 1176, 1160, 1088, 1076, 1002, 943, 919, 899 (C–O); 828, 709, 669, 597 (CH_{Ar})	205 (12000), 239 (4000), 350 (14000)
IIIl	3459, 3366 (NH); 3095, 3060, 3005 (=CH and CH_{Ar}); 2953, 2930, 2870 (CH_{Alk}); 1855, 1843, 1779, 1712 (C=O); 1623 (C=C); 1605, 1573, 1436, 1400, 1300 (Ar); 1465 (CH_2); 1277, 1255,1247, 1189, 1114, 1103, 1087, 1001, 947, 923, 906 (C–O); 761, 704 (CH_{Ar})	204 (22000), 242 (14000), 270 (8000)
IIIm	3378 (NH); 3053, 3030, 3005 (=CH and CH_{Ar}); 2956, 2933, 2868 (CH_{Alk}); 1855, 1842, 1778, 1692 (C=O); 1632 (C=C); 1603, 1585, 1544, 1514, 1388 (Ar); 1470, 1447 (CH_2); 1278, 1226, 1085, 947, 923, 905 (C–O); 853, 813, 748, 671 (CH_{Ar})	204 (45000), 238 (47000), 275 (7000)
IIIn	3035 (=CH); 2939, 2865 (CH_{Alk}); 1860, 1842, 1781, 1707 (C=O); 1630 (C=C); 1470, 1456, 1445 (CH_2); 1230, 1190, 1086, 1033, 1003, 947, 923, 905 (C–O)	205 (6000)
IIIo	3035 (=CH); 2956, 2939, 2868 (CH_{Alk}); 1860, 1843, 1780, 1696 (C=O); 1624 (C=C); 1460 (CH_2); 1232, 1192, 1105, 1087, 1024, 947, 923, 905 (C–O)	206 (6000)
IIIp	3035 (=CH); 2960, 2936, 2865 (CH_{Alk}); 1860, 1842, 1779, 1716 (C=O); 1621 (C=C); 1466, 1449 (CH_2); 1231, 1087, 1003, 947, 923, 905 (C–O)	205 (7000)
IIIq	3080, 3055, 3040 (=CH and CH_{Ar}); 2958, 2935, 2870 (CH_{Alk}); 1855, 1842, 1779, 1693 (C=O); 1640 (C=C); 1596, 1387 (Ar); 1466, 1445 (CH_2); 1231, 1087, 1004, 947, 923, 906 (C–O); 853, 752, 704 (CH_{Ar})	203 (8000), 251 (2000), 259 (2000), 262 (2000)
IIIr	3405 (OH); 3075, 3053, 3040 (=CH and CH_{Ar}); 2957, 2934, 2869 (CH_{Alk}); 1855, 1842, 1779, 1691 (C=O); 1637 (C=C); 1580, 1505, 1472, 1406, 1380 (Ar); 1464, 1446 (CH_2); 1279, 1226, 1208, 1193, 1163, 1088, 947, 923, 905 (C–O); 853, 825, 790, 709, 672 (CH_{Ar})	203 (31000), 242 (34000)
IIIs	3095, 3070, 3035 (=CH and CH_{Ar}); 2958, 2934, 2869 (CH_{Alk}); 1855, 1845, 1779, 1692 (C=O); 1623 (C=C); 1597, 1387 (Ar); 1227, 1210, 1086, 1005, 947, 923, 905 (C–O); 853, 747, 672 (CH_{Ar})	205 (19000), 255 (6000), 275 (4000)
IIIt	3070, 3053, 3030, 3000 (=CH and CH_{Ar}); 2955, 2928, 2867 (CH_{Alk}); 1855, 1841, 1778, 1690 (C=O); 1640 (C=C); 1585, 1433, 1386 (Ar); 1476, 1460 (CH_2); 1278, 1228, 1085, 1027, 1001, 946, 921, 904 (C–O); 852, 742, 694, 671, 566, 540 (CH_{Ar})	205 (57000), 262 (7000)
IVa	3077 (CH_{carb}); 2990, 2947, 2883 (CH_{Alk}); 2614, 2595, 2574, 2557 (BH); 1672 (C=O); 1326, 1312 (C–O); 841, 835 (CH_{carb}); 767, 718 (BH)	206 (200), 250 (40)
IVb	3204 (OH); 3077 (CH_{carb}); 2611, 2582 (BH); 1627 (C=O); 1615, 1570, 1493, 1470 (Ar); 1358, 1273 (C–O); 852 (CH_{carb}); 770, 719 (BH); 745 (CH_{Ar})	208 (20000), 237 (6000), 280 (3000)
IVc	3067 (CH_{carb}); 3004 (CH_{Ar}); 2955, 2918, 2862, 2825, 2810 (CH_{Alk}); 2625, 2605, 2580 (BH); 1736, 1614 (C=O); 1538, 1484, 1440 (Ar); 1382, 1260, 1174 (C–O); 811, 730, 716, 636, 610 (CH_{Ar} and BH)	204 (10000), 245 (6000), 340 (25000)

Table 3. (Contd.)

Comp. no.	IR spectrum, ν, cm^{-1}	UV spectrum, λ_{max}, nm (ε)
IVd	3076 (CH_{carb}); 2960, 2930, 2861 (CH_{Alk}); 2619, 2605, 2592, 2560, 2550, 2525, 2428 (BH); 1668, 1648 (C=O); 1455, 1447 (CH_2); 1338 (C–O); 843 (CH_{carb}); 772, 718 (BH)	206 (150), 212 (100)
IVe	3072 (CH_{carb}); 2990, 2975, 2960, 2947, 2940, 2864, 2830 (CH_{Alk}); 2625, 2607, 2576, 2560 2551, 2496 (BH); 1721, 1666, 1598 (C=O); 1353 (C–O); 843 (CH_{carb}); 767, 721 (BH)	208 (500), 221 (300), 313 (50)
IVf	3140, 3105, 3075, 3025 (CH_{Ar}); 3060 (CH_{carb}); 2622, 2570, 2555, 2543 (BH); 1655, 1636 (C=O); 1608, 1550, 1490 (Ar); 1331, 1251 (C–O); 845 (CH_{carb}); 770, 756, 718, 687, 589 (CH_{Ar} and BH)	204 (2500), 240 (800), 244 (1000), 252 (1400), 256 (1500), 263 (900)
IVg	3125, 3100, 3045 (CH_{Ar}); 3070 (CH_{carb}); 2648, 2608, 2568, 2541 (BH); 1652, 1640 (C=O); 1596, 1555, 1474, 1409 (Ar); 1327, 1304, 1275 (C–O); 845 (CH_{carb}); 814, 805, 771, 745, 714, 621, 580, 543 (CH_{Ar} and BH)	205 (30000), 242 (40000), 310 (2000)
IVh	3100, 3080, 3030 (CH_{Ar}); 3071 (CH_{carb}); 2605, 2580 (BH); 1727 (C=O); 1623, 1597 (Ar); 1396, 1349, 1282, 1215 (C–O); 838 (CH_{carb}); 770, 748, 730, 714 (CH_{Ar} and BH)	205 (14000), 255 (3500), 270 (2500)
IVi	3100, 3080, 3045, 3026, 3010, 3000 (CH_{Ar}); 3074 (CH_{carb}); 2607, 2570 (BH); 1733, 1655 (C=O); 1583, 1475, 1440 (Ar); 1261, 1120 (C–O); 840 (CH_{carb}); 742, 730, 710, 691, 491 (CH_{Ar} and BH)	205 (33000), 265 (8000)
Va	3060 (CH_{carb}); 3014, 2987, 2946, 2882 (CH_{Alk}); 2654, 2645, 2625, 2593 (BH); 1631 (C=O); 1443 (CH_2); 1331 (C–O); 833 (CH_{carb}); 783, 771, 749, 730 (BH)	207 (200), 220 (100)
Vb	3246 (OH); 3080, 3050, 3030 (CH_{Ar}); 3061 (CH_{carb}); 2604 (BH); 1623 (C=O); 1610, 1575, 1499, 1469 (Ar); 1361, 1280, 1120 (C–O); 853 (CH_{carb}); 739, 725 (CH_{Ar} and BH)	208 (21000), 238 (5000), 280 (3000)
Vc	3060, 3010 (CH_{Ar}); 3031 (CH_{carb}); 2950, 2918, 2850, 2831, 2810, 2781 (CH_{Alk}); 2603, 2573 (BH); 1733, 1591 (C=O); 1536, 1484, 1441 (Ar); 1380, 1274, 1251, 1171, 1125 (C–O); 840 (CH_{carb}); 812, 730, 714, 635, 600 (CH_{Ar} and BH)	205 (10000), 245 (7000), 340 (24000)
Vd	3050 (CH_{carb}); 3025, 2960, 2932, 2863, 2743 (CH_{Alk}); 2650, 2593 (BH); 1653, 1640, 1620 (C=O); 1472, 1454, 1440, 1435 (CH_2); 1349, 1330, 1322, 1119 (C–O); 867 (CH_{carb}); 784, 768, 749, 728, 624, 559 (BH)	207 (150), 211 (100)
Ve	3060 (CH_{carb}); 2983, 2942, 2864, 2830, 2775, 2740 (CH_{Alk}); 2603 (BH); 1726, 1650 (C=O;) 1460, 1450 (CH_2); 1350, 1131, 1117 (C–O); 855 (CH_{carb}); 780, 766, 750, 727, 624, 609, 577 (BH)	207 (500), 220 (300), 312 (50)
Vf	3205, 3145, 3134, 3102, 3073 (CH_{Ar}); 3060 (CH_{carb}); 2661, 1612, 2581 (BH); 1690 (C=O); 1605, 1533, 1485 (Ar); 1340, 1311, 1270, 1251, 1199, 1169, 1050 (C–O); 840 (CH_{carb}); 782, 770, 749, 730, 715, 675 (CH_{Ar} and BH)	205 (3000), 240 (800), 245 (1000), 253 (1500), 255 (2000), 264 (1000)
Vg	3102, 3030 (CH_{Ar}); 3060 (CH_{carb}); 2601 (BH); 1647 (C=O); 1617, 1591, 1546, 1471, 1407, 1382 (Ar); 1348, 1325, 1299, 1269, 1199, 1115, 1103 (C–O); 860 (CH_{carb}); 822, 805, 770, 748, 724, 710, 623, 580 (CH_{Ar} and BH)	204 (30000), 243 (41000), 311 (2000)
Vh	3110, 3048, 3000 (CH_{Ar}); 3060 (CH_{carb}); 2645, 2610, 2598, 2580 (BH); 1717 (C=O); 1625, 1600, 1458 (Ar); 1290, 1272, 1213, 1136, 1046 (C–O); 845 (CH_{carb}); 779, 760, 744, 722, 655, 621 (CH_{Ar} and BH)	205 (15000), 255 (4000), 272 (3000)
Vi	3095, 3050, 3020, 3010, 3000 (CH_{Ar}); 3058 (CH_{carb}); 2655, 2609 (BH); 1711, 1647 (C=O); 1582, 1475, 1434, 1430, 1420 (Ar); 1285, 1228, 1121, 1089, 1067 (C–O); 855 (CH_{carb}); 755, 741, 718, 692, 619, 539, 512, 490 (CH_{Ar} and BH)	205 (34000), 265 (7000)
VIa	3375, 3304 (OH and NH); 3100, 3051, 3025 (CH_{Ar}); 2980, 2974, 2894, 2850 (CH_{Alk}); 1710, 1697 (C=O); 1605, 1512, 1471, 1405, 1377 (Ar); 1282, 1269, 1218, 1169, 1125, 1086 (C–O); 924, 898, 847, 804, 765, 742 (CH_{Ar})	208 (37000), 235 (10000), 290 (5000)
VIb	3090, 3055, 3025 (CH_{Ar}); 2990, 2973, 2950, 2901, 2823, 2796 (CH_{Alk}); 1710, 1693, 1682, 1661 (C=O); 1600, 1549, 1535 (Ar); 1459 (CH_2); 1374, 1314, 1281, 1247, 1233, 1166, 1125 (C–O); 938, 825, 813, 728, 596 (CH_{Ar})	204 (18000), 242 (12000), 340 (52000)

Table 3. (Contd.)

Comp. no.	IR spectrum, ν, cm^{-1}	UV spectrum, λ_{max}, nm (ε)
VIc	3459, 3367 (NH); 3095, 3060, 3040 (CH_{Ar}); 3000, 2985, 2975, 2953, 2890, 2840 (CH_{Alk}); 1712 (C=O); 1624, 1606, 1574, 1560, 1455, 1437, 1401 (Ar); 1300, 1277, 1255, 1250, 1115, 1000 (C–O); 910, 868, 828, 761, 705 (CH_{Ar})	203 (44000), 245 (45000), 280 (23000), 345 (5000)
VId	3411, 3343, 3225 (NH); 3085, 3055, 3043 (CH_{Ar}); 2985, 2973, 2920, 2880 (CH_{Alk}); 1710, 1696, 1635 (C=O); 1624, 1590, 1575, 1513, 1459, 1406, 1376 (Ar); 1288, 1247, 1167, 1125, 1013 (C–O); 792, 770, 717 (CH_{Ar})	212 (85000), 243 (46000), 370 (10000)
VIe	3394, 3317, 3201 (NH); 3085, 3048, 3025, 3000 (CH_{Ar}); 2990, 2974, 2950, 2890 (CH_{Alk}); 1710, 1697, 1630 (C=O); 1599, 1512, 1470, 1376 (Ar); 1281, 1225, 1223, 1183, 1124 (C–O); 855, 845, 814, 742, 713 (CH_{Ar})	212 (34000), 240 (82000), 270 (6000), 280 (7000), 290 (6000)
VIf	2975, 2939, 2863 (CH_{Alk}); 1720, 1623 (C=O); 1458 (CH_2); 1383, 1357, 1304, 1243, 1132 (C–O)	205 (1500), 220 (1500)
VIg	2982, 2937, 2863 (CH_{Alk}); 1623 (C=O); 1458 (CH_2); 1386, 1362, 1244, 1200, 1157 (C–O); 872 (O–O)	204 (1000)
VIh	3090, 3065, 3048, 3030 (CH_{Ar}); 2990, 2974, 2891 (CH_{Alk}); 1709, 1697 (C=O); 1579, 1508, 1473, 1434, 1410, 1379 (Ar); 1285, 1275, 1246, 1223, 1207, 1167, 1125, 1093, 1059 (C–O); 818, 781, 742, 711, 637 (CH_{Ar})	205 (18000), 242 (25000), 325 (3000)
VIi	3080, 3066, 3050, 3025, 3015, 3000 (CH_{Ar}); 2970, 2885 (CH_{Alk}); 1710, 1697 (C=O); 1583, 1475, 1434, 1376 (Ar); 1280, 1246, 1168, 1121, 1090, 1025 (C–O); 742, 723, 696, 542, 513, 499, 492 (CH_{Ar})	210 (68000), 260 (26000)
VIIa	3375, 3304 (OH and NH); 3090, 3055, 3025 (CH_{Ar}); 2650, 2618, 2595, 2560 (BH); 1624 (C=O); 1605, 1570, 1507, 1492, 1470, 1407 (Ar); 1346, 1321, 1277, 1190, 1132 (C–O); 897, 853, 741, 550 (BH and CH_{Ar})	208 (40000), 235 (11000), 290 (6000)
VIIb	3095, 3050, 3000 (CH_{Ar}); 2950, 2918, 2855, 2828 (CH_{Alk}); 2637, 2600, 2571 (BH); 1726, 1660 (C=O); 1598, 1536, 1440 (Ar); 1379, 1320, 1260, 1232, 1170, 1065 (C–O); 817, 730, 634, 606, 506 (BH and CH_{Ar})	205 (19000), 245 (13000), 341 (55000)
VIIc	3459, 3366 (NH); 3095, 3060, 3040, 3000 (CH_{Ar}); 2951, 2900, 2845 (CH_{Alk}); 2610 (BH); 1713 (C=O); 1623, 1606, 1573, 1437, 1400 (Ar); 1300, 1277, 1260, 1250, 1196, 1115, 1000 (C–O); 870, 761, 730, 705 (BH and CH_{Ar})	203 (43000), 245 (44000), 280 (24000), 350 (6000)
VIId	3412, 3344 (NH); 3055, 3045 (CH_{Ar}); 2670, 2602, 2560 (BH); 1719, 1625 (C=O); 1603, 1577, 1545, 1515, 1455, 1404 (Ar); 1349, 1273, 1130 (C–O); 794, 768, 730, 703 (BH and CH_{Ar})	212 (84000), 244 (47000), 370 (9000)
VIIe	3395, 3319, 3200 (NH); 3050, 3005 (CH_{Ar}); 2670, 2626, 2611, 2585 (BH); 1740, 1626 (C=O); 1608, 1564, 1513, 1469, 1372 (Ar); 1281, 1269, 1225, 1184, 1137, 1124 (C–O); 848, 810, 773, 743, 705, 624, 470 (BH and CH_{Ar})	212 (35000), 240 (83000), 270 (5000), 280 (6000), 290 (5000)
VIIf	2975, 2940, 2862 (CH_{Alk}); 2605 (BH); 1723, 1650 (C=O); 1450 (CH_2); 1340, 1130 (C–O); 770, 754, 739, 608, 576, 501 (BH)	205 (1500), 315 (100)
VIIg	2983, 2938, 2862 (CH_{Alk}); 2607 (BH); 1646 (C=O); 1454 (CH_2); 1362, 1336, 1244, 1190, 1157, 1127, 1071, 1037 (C–O); 871 (O–O); 754, 737, 586, 524 (BH)	205 (1500)
VIIh	3419 (OH); 3090, 3068, 3025 (CH_{Ar}); 2608 (BH); 1733, 1713, 1634 (C=O); 1603, 1595, 1557, 1504, 1473, 1420, 1400, 1375 (Ar); 1334, 1307, 1274, 1208, 1099 (C–O); 821, 803, 780, 765, 751, 725, 710, 622, 576 (CH_{Ar})	205 (19000), 242 (26000), 330 (3000)
VIIi	3085, 3067, 3047, 3030, 3010, 3000 (CH_{Ar}); 2611 (BH); 1739, 1634 (C=O); 1583, 1475, 1435 (Ar); 1237, 120, 1089, 1069, 1025, 997 (C–O); 742, 723, 695, 619, 541, 513, 498, 490 (CH_{Ar})	211 (70000), 262 (27000)

Ie, IVb, IVe, IVg, Vb, Vg,VIa–**VIi**, and **VIIa**–**VIIi**), reference TMS. The UV spectra were obtained on a Specord UV-Vis spectrophotometer for 1×10^{-3} M solutions in *n*-butanol. Thermal analysis was performed on a Paulic–Paulic–Erdey derivatograph in argon, linear heating rate 7 deg/min, sample 100 mg, DTA 1/10, and DTG 1/10 [35]. Maleopimaric acid was prepared and purified as described in [10], *o*- and *m*-carborane-1-carboxylic acids and *m*-carborane-1,7-dicarboxylic acid were prepared as described in [36].

Nitrogen- and phosphorus-containing carboxylic acid salts IIIa–**IIIt, IVa**–**IVi, Va**–**Vi, VIa**–**VIi, and VIIa**–**VIIi** *(general procedure).* Compound **II**, 0.05 mol, was added to a solution of 0.005 mol of acid **Ia**–**Ic** in 20 ml of absolute chloroform (or 0.0025 mol of acid **Id** or **If** in 20 ml of absolute methanol). When compound **II** had dissolved completely, the solvent was removed, and the residue subjected to a vacuum at a temperature not higher than 40–50°C. Salts **IIIa**–**IIIt**, **IVa**–**IVi**, **Va**–**Vi**, **VIa**–**VIi**, and **VIIa**–**VIIi** were obtained as homogeneous brittle porous materials.

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