ABSORPTION SPECTRA OF BENZOLOGS OF QUINOLIZINIUM IONS

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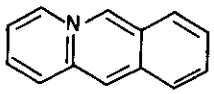
The ultraviolet absorption spectra of quinolizinium ions are reviewed.

In the last two decades a large number of benzologs of quinolizinium salts have been synthesised by various research groups. Their u.v. spectroscopy on the one hand has played an important role in determining the structure of both simple and complex molecules and on the other hand has helped in the study of the reaction mechanism. Of the three benzologs, acridizinium system has been studied extensively.

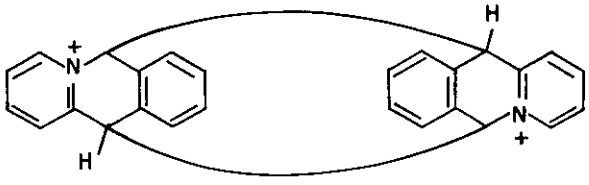
Acridizinium Salts

The ultraviolet absorption spectra of acridizinium salts consist of 4 intense bands in the region 242-399 nm, the intense colour being due to the band in the region of 399 nm. With the substituents at the different positions, the mixmum intensity of the band increases with deepening in colour which clearly indicates a high degree of conjugation. In alcoholic solution acridizinium bromide gives an intense blue-violet fluorescene from which it crystalises as long yellow prisms.

Irradiation of the acridizinium bromide (I) destroys the conjugation characteristic of the acridizinium system in the formation of a dimer (II) and its property of dissociation at slow rate at room temperature, but rapidly on heating was demonstrated by studying the ultra-



I

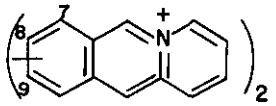


II

violet spectrum of the reaction mixture [1].

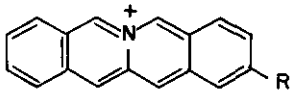
In the bis-quarternary system, 7,7'-bis(acridizinium bromide) (III) a non-planer molecule resembled closely to that of the simple acridizinium ion in the absorption spectrum, although with a small bathochromic shift, whereas the spectrum of 9,9'-bis(acridizinium bromide) (IV) is more complex and shows significant absorption at higher wave lengths. Both these spectra make

an interesting comparison with that of acridizinium perchlorate[2].



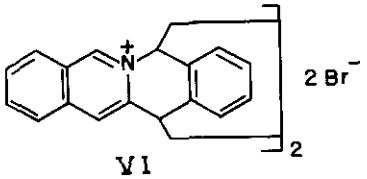
III = 7,7'-
IV = 9,9'-

The UV absorption spectra of benz(b)acridizinium bromide (V) and its dimers are quite different in that, the dimer (VI) does not absorb at the longer wave length. This makes it clear that the dimerisation has destroyed the conjugation characteristic of the benz(b)-acridizinium system. The similarity of the spectrum to that of 2-(2-methylbenzyl)-3-methyl-



R = H
R = CH_3

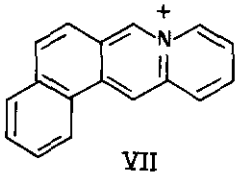
V



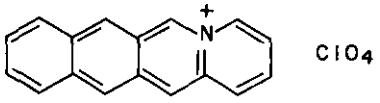
VI

isoquinolonium bromide indicates, that the absorbing groups in the dimer are isolated benzene and isoquinolinium structures, which is apparently due to dimerisation involving an inner rather than a terminal ring[3].

The UV spectra has also been used in establishing the structure of benzo(j)acridizinium bromide (VII) based on the annulation principle developed by Clar [4] for aromatic hydrocarbons.



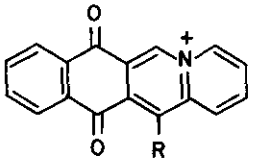
VII



VIII

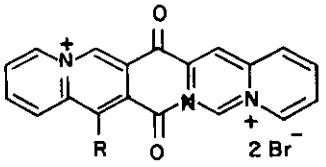
A small increase of 50 A^0 in the absorption maxima shown by benzo(j)acridizinium bromide with the assumption that linear annulation has occured which indicates that formula (VII) is to be preffered over the linear formula (VIII)[5].

The UV spectrum of 6a-azonianaphthacene quinone (IX) showed a small difference between the spectra of its acidified (yellow) and the neutral (blue) solution and only a significant difference in the case of the phenyl analog (X). The neutral solution of X, when exposed to diffuse day light for only five days changes to yellow-brown and the absorption spectrum is greatly altered [6].



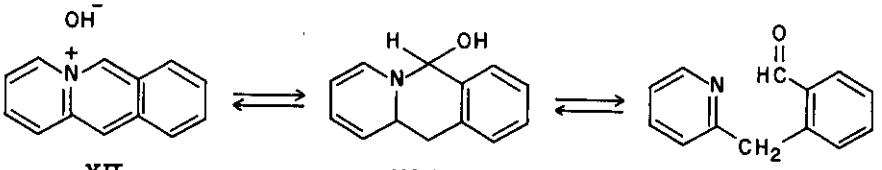
X, R=C_6H_5
IX, R=H

On the other hand, the spectra of 4a,11a-diazoniapentacene-6,13-quinone dibromide (XI) in the neutral and acidified solutions in methanol indicate that the attack of the solvent under neutral conditions upon the aromatic system of the quinone (XI,XII) must be more extensive than was observed with X [7].



XI; R=H XII; R= C_6H_5

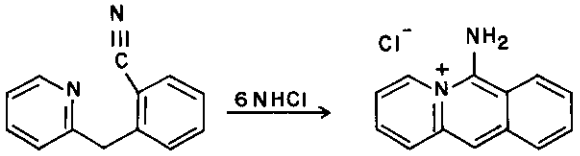
Aston and Montgomery [8] pointed out on the basis of spectroscopy that in aqueous solution acridizinium hydroxide (XIII) is largely ionic and in equilibrium with only a small amount of the pseudo base (XIV), the UV spectrum of which showed the usual aciridizinium peaks plus an additional peak at 417 nm attributed to the pseudo base. Also the existance of the pseudo base in equilibrium with the aldehyde (XV) in basic solution was deducted by studying the



XII XIV XV

reaction spectrophotometrically.

The UV spectrum has also been helpful in determining the structure of 6-aminoacridizinium bromide (XVI) by heating the nitrile (XVII) with 6N hydrochloric acid at 100°, where as the same

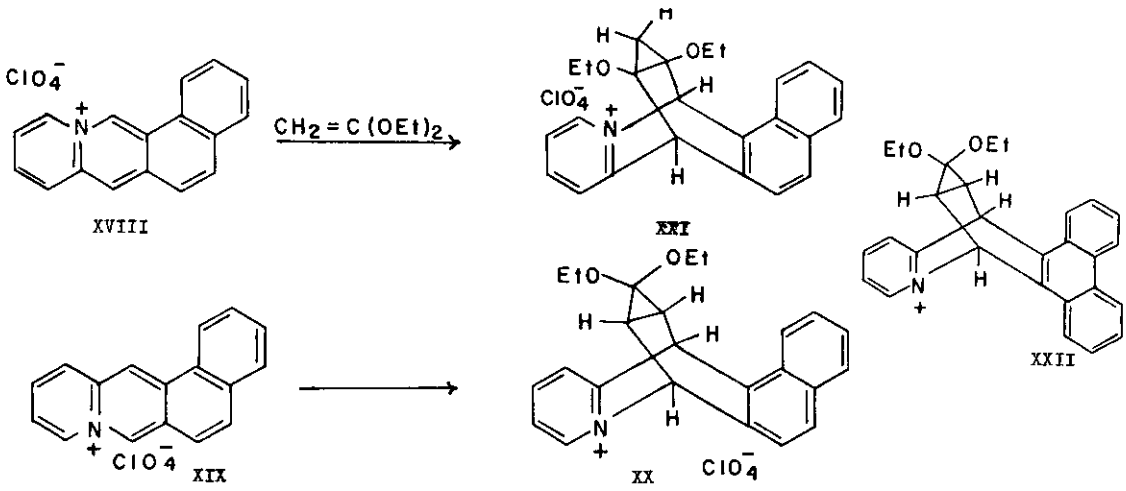


XVII XVI

nitrile with magnesium iodide followed by cyclisation with concentrated sulphuric acid yielded 6-phenylacridizinium ion, the UV spectrum of which was found to be very similar to that of the isomeric 11-phenylacridizinium cation [9].

The structure of the adducts arising from the addition of dienophiles to the acridizinium ion was deducted from the UV absorption spectra. The absorption in the region 260-275 nm indicates the expected cycloaddition of the dienophiles across the 9,10 position of the acridizinium ion [10]. An adduct with the styrene does not show any absorption below 264 nm, which makes it possible to follow the disappearence of the strong absorption peak at 399 nm. In case of an adduct of azonianaphthacene (XVIII,XIX) with ketens diethylacetal, the addition has been shown to occur across ring A rather than ring B, a conclusion, which has been based on the longer wave length of the UV absorption of XX (372 nm) as compared to (348, 296 nm) in case of XXI and XXII [10-14] respectively.

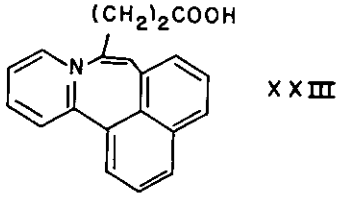
The adduct of acrixizinium ion with maleic anhydride had an ultraviolet absorption spectrum resembling that of the acridizinium dimer in that, absorption was confined to 263 nm region. This clearly indicates, that the absorbing groups are isolated pyridine and benzene



system. If on the other hand the reaction had involved one of the terminal rings, the absorbing group would then be napthalene or isoquinoline with absorption to be expected at a longer wave length [44].

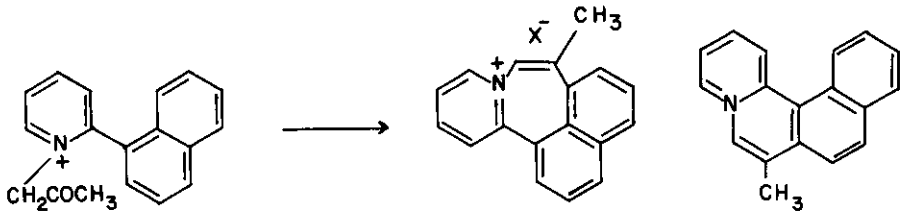
Phenanthrdizinium Salts

In the phenathridizinium series the UV spectral data is helpful in the identification of the compound formed from 2-(1-naphthyl)pyridine and methyl δ-bromolevulinate. The product 7-methyl (1,m) morphanthridizinium salt (XXIII) suggested, that in case of simple analogs [15] cyclisation has occurred into the α-position of the naphthalene ring rather than to the β-postion to form a six membered ring [16].



XXIII

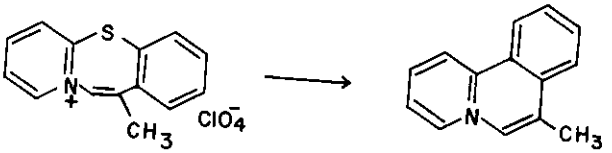
Similarly, the structure of 7-methylbenzo (1,m)morphanthridizinium salt (XXIV) from the cyclisation of 1-acetonyl-2-(1-naphthyl)pyridinium bromide (XXV) was estiblished with the help of UV spectroscopy [15]. Previously the compound was considered to have a structure



XXV XXIV XXVI

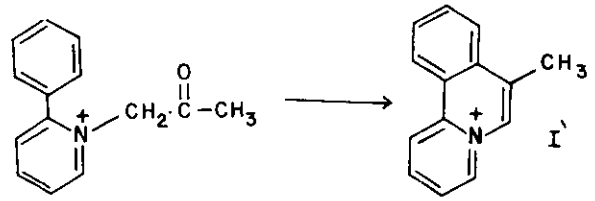
of 7-methylbenzo(k)phenanthridizinium perchlorate (XXVI).

The formation of 7-methylphenanthridizinium perchlorate (XXVII) by extrusion of sulphur from pyrido(2,1-b)benzo(f) (1,3)thiazepinium salt (XXVIII) was shown by studying the thermal reaction spectrophometrically [17]. The reaction was carried out under controlled conditions, with aliquots being examined spectrophotometrically. It was concluded from the complete absorption spectrum that the decrease in optical density is even more evident at shorter wave lengths and at temperature of 100° for about 2 hours with the optical density of 0.916, the yield of product increased to 68%, which is quite evident from the UV absorption spectra of these compounds.



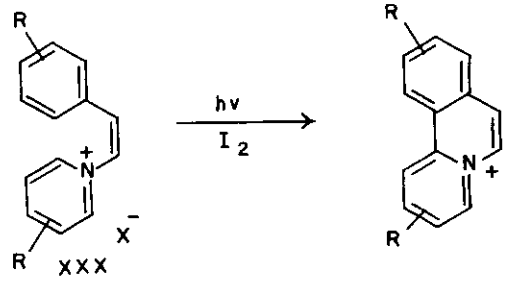
XXVIII XXVII

Cyclisation of N-acetonyl-α-pyridinium iodide (XXIX)to 7-methylphenanthridizinium iodide was shown to occur by studying its UV spectrum, which made it clear, that cyclisation reaction has resulted in an increase in molecular extinction coefficient and a shift towards longer wave length. These effects would be predicted for a transition from a restricted bi-phenyl type of structure to a planar polycyclic aromatic one [18].



XXIX

The progress in the formational phenanthridizinium salts by irradiation of styryl-pyridinium salts (XXX) was also followed by observing the UV absorption spectra of sample



XXX

withdrawn at regular intervals and it was found that the optimum reaction time was about 24 hours[19].

Solvents

a- Ethanol

b- Methanol

c- Acetonitrile

d- Water

Compound	Solv.	Absorption maxima max nm/ log$_e$	Absorption minima max nm/ log$_e$	Ref.
Acridizinium Perchlorate	a	242, 361,379.5, 399	311, 396, 398.5	33
		(4.68; 3.90; 4.01; 3.93)	(3.15; 3.88; 3.81)	
4-Methylacridizinium perchlorate	a	200, 243, 250 sh, 364, 381	214, 313, 372.5, 391	28
		(4.38; 4.52; 4.50; 3.90; 3.81)		
7-Methylacridizinium perchlorate	a	250, 366, 388.5, 408	316.5, 377.5, 399.5	33
		(4.78; 3.99; 4.0; 3.95)	(3.21; 3.89; 3.88)	
9-Methylacridizinium perchlorate	a	244.5, 379, 398	314, 392	33
		(4.71; 3.09; 3.93)	(3.08; 3.90)	
11-Phenylacridizinium perchlorate	a	245, 365, 383, 404	317, 375, 393	40
		(4.52; 3.99; 3.98; 3.91)	(3.20; 3.90; 3.78)	
6-Phenylacridizinium perchlorate	a	248, 285 sh, 345 sh	331	9
		(363; 386; 406)	(3.94)	
		(4.63; 4.0; 3.70)		
		(3.93; 3.96; 3.91)		
7-Phenylacridizinium perchlorate	a	249, 365, 386	255, 311, 380	2
		(4.79; 4.45; 4.380)	(4.62; 3.86; 4.37)	
11-Methylacridizinium Perchlorate	a	243, 250, 365, 382	247, 313, 372, 391	40
		(4.61; 4.60; 4.04; 4.0)	(4.58; 3.08; 3.93; 3.82)	
6-Cyanoacridizinium perchlorate	a	(364, 395, 408, 432)		39
6-Aminoacridizinium perchlorate	a	235 sh, 241, 257 sh		9
		340 sh, 380, 405, 427		
		(4.55; 4.56; 4.25; 3.68		9
		4.06; 4.04; 3.88)		
11-Benzylacridizinium perchlorate	a	240, 250, 366, 382, 404		37
		(4.45; 4.46; 3.82; 3.83;3.75		
7,7-bis(Acridizinium Bromide)	a	440, 263,383, 406	315, 372, 392	2
		(4.27; 4.24; 4.32; 4.74)	(3.55; 4.13; 4.14)	

Compound	solv.	Absorption maxima max nm./ $\log_e$	Absorption minima Max.nm./ $\log_e$	Ref.
9,9'-bis(Acridizinium Bromide)	a	(243, 266, 308, 310, 366, 410, 431)	255, 279, 307, 347, 374, 417	2
		(4.74; 4.60; 4.78; 4.77; 4.15; 4.38; 4.42)	(4.52; 4.51; 4.76; 3.95; 4.11; 4.34)	2
8,8'-bis(Acridizinium Bromide)	a	242, 318-26 sh, 367, 380 sh, 397 sh. (4.70; 3.95; 4.26; 4.18; 3.60	331 (3.94)	2
9,9'-Methylenebis-(acridizinium Bromide)	a	244, 250 sh, 277 sh, 362, 374 394 (4.96; 4.93; 4.74; 4.42; 4.50; 4.41)	318, 366, 385 (372; 4.38; 4.28)	2
9,9'-Ethylenebis-(acridizinium Bromide)	a	245, 252, 362, 376, 393, 395 (4.79; 4.80; 4.52; 4.20; 4.26; 4.12)	249, 304, 368, 388 (4.78; 3.34; 4.17; 4.03)	2
Benz(a)acridizinium Bromide	a	260, 279, 296, 309, 346, 364 383, 403, 475, 507	239, 265, 287, 304, 338 355, 370, 391	42
13-Phenylbenz(a)-acridizinium perchlorate	a	261.5, 311.5, 387, 406 (4.56; 4.15; 4.34; 4.23)	242, 289, 344, 369 (4.42; 4.20; 3.8; 4.08)	35
10-Methoxy-13-phenylbenz(a)-acridizinium perchlorate		223, 269, 311.5, 400, 421 (4.59; 4.55; 3.93; 4.03)		
9-Methyl-13-phenylbenz(a) acridizinium perchlorate	a	224, 266, 314.5 396, 405 (4.53; 4.54; 4.31; 3.76; 3.84)	247, 293, 346.5, 404 (4.42; 4.56; 4.31; 4.51)	35
7-Phenylbenz(h)-acridizinium perchlorate	a	231, 275, 305.5, 339, 388 (4.07; 4.071; 4.14; 3.54; 3.98	250, 294, 313.5, 339, 388 (4.07; 4.07; 4.14; 3.54;3.98)	35
7-Methylbenz(h)-acridizinium perchlorate	a	231, 276, 307, 320, 361, 379,400 (4.39; 4.50; 4.16; 4.23; 3.50; 4.17 4.37)	248, 290, 312.5, 337, 366 388 (3.97; 3.92; 4.10; 3.55; 3.80; 3.91)	35
15-phenyldibenz(a,h)-acridizinium Bromide	a	278.5, 306.5, 390, 411 (4.42; 4.56; 4.31; 4.51)	254, 285.5, 346.5, 401 (4.29; 4.41; 3.78; 4.12)	35
Benzo(j)acridizinium perchlorate	a	227, 276, 321.5, 364, 384,405.5 (4.52; 4.57; 4.55; 3.91; 3.89)	248, 289.5, 310, 336.5 (4.07; 4.14; 3.87; 3.76;3.71)	5

Compound	Solv.	Absorption maxima max nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
Benzo(h)acridizinium perchlorate	a	232.5, 274, 305, 317, 358, 376, 395 (4.54; 4.58; 4.33; 4.39, 3.93; 4.22; 4.34)	248, 289.5, 310, 336.5, 361, 384 (4.04; 4.20; 4.28;3.64, 3.92; 4.03)	5
Dibenzo(h,j)acridizinium Perchlorate	a	236, 255, 280, 307, 339, 374, 394 (4.50; 4.45; 4.45; 4.60; 4.08; 4.03, 4.10)	250, 267, 285.5, 322.5, 361.5, 383.5 (4.42; 4.37; 4.39; 4.06, 3.86; 3.94)	5
Dibenzo(b.h)acridizinium Bromide	a	294, 305, 346, 404, 426, 464 (4.56; 4.68; 4.85; 4.27 4.11; 4.30; 3.59)	223, 269, 290, 337, 376, 408, 457 (4.40; 4.36; 4.67; 4.22, 3.76; 4.11; 3.54	30
Dibenzo(b,j)acridizinium Bromide	a	256, 287, 345, 360, 410 433, 462 (4.70; 4.65; 4,48; 4.53; 4.25; 4.40; 3.67)	230, 267, 326, 352, 378 430, 456 (4.46; 4.45; 4.31; 4.45, 3.76; 4.18; 3.18)	30
6-Methyl-11-phenylacridizinium perchlorate	a	249, 370, 389, 410, (4.65; 4.11; 4.09; 4.05)	318, 325, 400 (3.24; 3.98; 3.90)	40
7-Methyl-11-phenylacridizinium perchlorate	a	252, 371, 391, 412 (4.57; 4.00; 4.00; 3.97)	247, 382, 403 (4.61; 4.15; 3.90)	40
9-Methyl-11-phenylacridzinium perchlorate	a	247, 382, 403 (4.61; 4.15; 3.96)	317, 395 (3.15, 3.94)	40
2-Methylbenz(b)acridizinium Bromide	a	240, 257, 289, 340, 398,420 (4.12, 4.06, 4.28, 3.59,3.43)	252, 262, 317, 368 404, 448, 478 (4.05, 4.04; 3.57; 3.88; 3.40; 3.11; 3.45)	5
8,9-Methylenedioxyacridizinium Bromide	a	258, 377, 396		34
7,8-Methylendioxyacridizinium Bromide	a	318, 387, 402	294, 354	34
2,3-Methylenedioxyacridizinium Chloride		256, 304, 400, 421, 448, 478 (4.52, 4.62, 3.84, 4.13,3.71, 3.42)	270, 378, 407, 440,465 (4.2; 3.45; 3.8; 3.67; 3.3)	30

Compound	Solv.	Absorption maxima max nm. / $\log_e$	Absorption Minima max nm./ $\log_e$	Ref.
9,10-Methylenedioxybenz(a)-acridizinium perchlorate	a	299,262,284,328,340	244,275,300,335,363	42
3-Methoxyacridizinium Bromide	a	264,285,338,400,423 (4.53;4.60;4.23;3.95;4.37)	228,269,325,384,387 4.15;4.48;4.14;3.50;3.87)	30
8-Methoxyacridizinium perchlorate	a	356,394,410		34
8-Hydroxyacridizinium Bromide	a	364,394,410		34
2,3-Dimethoxyacridizinium chloride	c	257,304,400,427,456,485 (4.49;4.67;3.97;4.28; 3.75;3.42)	232,271,380,408,446,475 (4.15;4.32;3.59;3.94; 3.72;3.34)	30
3,10-Dimethyl 4a-azoniapentaphene perchlorate	c	211,253,256,sh,286,298, 340,353,364,384 (4.64;4.02;4.01;4.24;4.70; 4.51;4.56;4.38;4.51;3.64; 3.61)		30
3,4-Dimethoxyacridizinium chloride	a	280,355,413,436 (4.68;4.48;4.12;4.13)	230,315,400,420 (4.45;4.37;4.07;4.12)	23
5,6-Dihydroxyacridizinium Bromide	b	245,347,363 (4.07;4.05;4.08)		29
5,6-Diacetoxyacridizinium bromide	b	248,283,357,382,402 (4.79;4.09;4.01;3.97;3.95)		29
5,8-Dihydroxyacrididizinium bromide	b	248,375 (4.41;3.73)		29
5,8-Diacetoxyacridizinium bromide	b	250,364 (4.78;3.73)		29
7,8-Dimethoxyacridizinium Bromide	a	260,302,372,438	290,342,407	34
6-Methyl-8,9-dimethoxyacridizinium bromide	a	368,382,401		38
6-Ethyl-8-ethoxy-9-methoxy-acridizinium perchlorate	a	370,384,404		38
6-Ethyl-8,9-diethoxyacridizinium perchlorate	a	370,385,405		38

Compound	Solv.	Absorption maxima max. nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
7,10-Dimethoxy-11-phenyl-acridizinium perchlorate	a	250,323 sh,409,454 (5.08;3.31;4.02;3.84)	245,294,400,450,482	21
9,10-Dimethoxybenz(a)acridizinium perchlorate	a	259,317,332,473,504	245,294,400,450,482	42
10-Methoxy-13-phenylacridizinium perchlorate	a	223,269,311.5,400,421 (4.59;4.55;3.93;4.03)	243,289,384,408 (4.07;4.37;3.72;3.91)	35
10-Methoxybenz(a)acridizinium bromide	a	270,296,309,323,345,397, 417	243,286,319,370,380,405	42
8-Methoxy-11-phenylacridizinium perchlorate	a	259,298,344,363,400,420 (4.46;4.23;3.81;4.04; 4.0;3.75)	287,335,350,385,405 (4.20;3.72;3.78;3.64; 3.70)	40
5,6-Dihydroxy-8-phenylacridizinium perchlorate	b	340 sh,356,372,400 (4.90;4.18;4.65;4.06)		29
5,6-Diacetoxy-8-phenylacridizinium perchlorate	c	240,250,366,390,410 (4.64;4.56;4.12;3.92;3.88)		29
4a,7a-Diazoniapentacene-6,13-dione dibromide	d	253,383 (4.78;4.36)		29
4a,11a-diazoniapentacene-6,13-dione dibromide	b	224,251,377 (4.66;4.70;4.41)		29
6,7-Dihydroxy-4a,8a-diazoniapentaphene dibrimide	b	245,262,363,380 (4.51;4.42;4.61;4.60)		29
7,8-Dihydroxy-5a,8a-diazoniaheptaphene bisperchlorate	d	248,269,300 sh,440 (4.52;4.54;4.34;4.43)		29
Indolo(2,3-a)acridizinium perchlorate	a	209,255,280,288 sh,346, 401,443 (4.29;4.44;4.19;4.17;4.24;3.83)		36
8,13-Dimethyl-13-H-indolo-(2,3-a)acridizinium perchlorate	a	202,230,255,273,285 sh (332 sh,345,410,440,) (4.4,4;64;4.63;4.40;4.31;4.37; 4.0;4.11;3.93)		32
3-Methoxyindolo(2,3-a)acridizinium perchlorate	b	258,268 sh,330,405,440 (4.36;4.33;4.29;3.82;3.49)		36

Compound	Solv.	Absorption maxima max nm./ $\log_e$	Absorption minima max. nm./ $\log_e$	Ref.
3,4-Dimethoxyindolo(2,3-a)acridizinium perchlorate	c	260,290,350,385,480 (4.53;4.37;4.50;4.11;3.90)		36
6a-Azonianaphthacene quinone bromide (Acidified 10^{-3} M)	b	237,248 sh,312 sh,358,372 (4.54;4.37;3.81;4.05)		6
6a-Azonianaphthacene quinone perchlorate	c	253,336 sh,337 (4.55;4.14;4.16)		6
After exposure to light for 5 days	b	228,243 sh (4.70;4.67)		6
Freshly prepared quinone bromide	b	247,322,sh,322 sh,372 sh (4.47;3.68;4.11;4.13)		6
Freshly prepared quinone perchlorate	b	253,363 sh,377 (4.54;4.18;4.15)		6
2,3,10,11-Tetramethoxybenz(a) acridizinium chloride	a	278,309,322,417	250,286,318,370	31
2,3,9,10-Tetramethoxybenz(a)-acridizinium bromide	a	246,285,355,464	268,306,344,404	31
2,3-Dimethoxy-9,10-methylene-dioxybenz(a)acridizinium chloride	a	248,275,327,358,492	262,304,340,417	31
2,3-Dimethoxy-10,11-methylene-dioxybenz(a)acridizinium chloride	a	276,309,322,413	250,285,317,367	31
2,3,10-Trimethoxybenz(a)acridizinium chloride	a	277,312,332,435	250,286,318,370	31
2,3,9,10-Bismethylenedioxybenz-(a)acridizinium chloride	a	248,356,490	264,294,337,418	31
11,11-Dimethyl-6,11-dihydro-acridizinium perchlorate	a	264 (3.78)		37
7,13-Dihydrobenz(h)acridizinium bromide	a	267 (3.75)		37
11-Benzyl-11-methyl-6,11-dihydro-acridizinium bromide	a	266 (3.77)		37
Beatain of 10-sulphoacridizinium bromide	a	200 sh,228,sh,236,254 sh, 330,353,376,396 (4.18;4.14;4.19;3.88;2.99 3.24;3.20;3.13)		41

Compound	Solv.	Absorption maxima max. nm./ $\log_e$	Absorption minima max. nm./ $\log_e$	Ref.
10-Phenylsulphonyl)acridizi-	a	237,255 sh,360,382,402		41
nium bromide		(4.11;3.64;3.38;3.28;3.06)		
6-Methyl-12-phenyl-6,11-dihydro-	a	272,265 sh		43
6,11-*ethanoacridizinium* per-		(3.76;3.74)		
chlorate				
11-Methyl-12-phenyl-6,11-dihydro-	a	270,266 sh		43
6,11-ethanoacridizinium per-		(3.73;3.71)		
chlorate				
6,11,12,15-Tetrahydro 6,11,3,4-	a	263	241.5	44
furanoacridizinium-13,15-dione		(3.62)	(3.38)	
bromide				
cis-12,13-dicarboxy-6,11-dihy-	a	263	241.5	44
dro-6,11-ethanoacridizinium		(3.58)	(3.33)	
perchlorate				
trans-12,13-dicarbethoxy-6,11-	a	263	242	44
dihydro-6,11-ethanoacridizinium		(3.73)	(3.49)	
perchlorate				
trans-12,13-dicarbomethoxy-6,11-	a	264	244	44
dihydro-6,11-ethanoacridizinium		(3.60)	(3.38)	
perchlorate				
cis-12,13-dicarbethoxy-6,11-	a	262	241	44
dihydro-6,11-ethanoacridizi-		(3.78)	(3.51)	
nium perchlorate				
cis-12,13-dicarbomethoxy-6,11-	a	263	241	44
dihydro-6,11-ethanoacridizinium		(3.76)	(3.49)	
perchlorate				
12- or 13-cyano-6,11-dihydro-	a	261	239	44
6,11-ethanoacridizinium		(3.68)	(3.41)	
perchlorate				
anti-12,13,15,16-Tetrahydro(6,11,	a	263	241	
3,4)furanoacridizinium 13,15-		(3.75)	(3.54)	10
dione dibromide				
anti,anti-12,13-dicarboxy-6,11-	a	263	241	10
ethanoacridizinium perchlorate		(3.75)	(3.54)	

Compound	Solv.	Absorption maxima max nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
anti,anti-12,13-dicarbomethoxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	260 (3.71)	249 (3.49)	10
anti,anti-12,13-Dicarboethoxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	263 (3.73)	240 (3.49)	10
anti,syn,-12,13-Dicarboxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	263 (3.70)	240 (3.47)	10
anti,syn-12,13-Carbomethoxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	263 (3.76)	240 (3.46)	10
anti,syn-12,13-Dicarboethoxy-dihydro-6,11-ethanoacridizinium perchlorate	a	263 (3.70)	242 (3.49)	10
Syn,syn,12,13-Dicarboxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	263 (3.70)	242 (3.50)	10
Syn,syn-12,13-Dicarbomethoxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	264 (3.60)	240 (3.50)	10
Syn,syn-12,13-Dicarboethoxy-6,11-dihydro-6,11-ethanoacridizinium perchlorate	a	262 (3.60)	244 (3.38)	10
PHENANTHRIDIZINIUM SALTS				
Phenanthridizinium perchlorate	a	217,222,237,256 sh,269, 278,323,337,354, (4.29;4.32;4.28;4.08;4.23; 4.28;3.70;4.01;4.14)		20
7-Methylphenanthridizinium perchlorate	a	220 sh,280,300 sh,330, 340,360 (4.5;4.4;4.0;4.1)	230,254,290,350 (4.3;4.2;3.8;3.7)	22
8-Methylphenanthridizinium perchlorate	a	272 sh,285,325,341,357 (4.47;3.79;3.89;4.08)		19

Compound	Solv.	Absorption maxima max nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
9-Methylphenanthridizinium Perchlorate	a	219 sh,225,242,272,278sh, 308 sh,323,338,354 (4.33;4.38;4.35;3.76; 3.83;4.11;4.26)		20
10-Methylphenanthridizinium perchlorate	a	263,275 sh,285,329,344,361 (4.18;4.31;3.66;3.98;4.13)		19,20
11-Methylphenanthridizinium perchlorate	a	220,274,330,344,360 (4.62;4.69;3.77;3.97;4.06)		20
7-Phenylphenanthridizinium bromide	a	290,330,350,360		16
10-Chlorophenanthridizinium perchlorate	a	250 sh,265 sh,280,330,345,363 (4.14;3.55;3.80;3.90)		1717
8-Benzoxyphenanthridizinium Perchlorate	a	260 sh,271 sh,281,324,339,355 (4.49;3.84;4.05;4.13)		1919
1,7-Dimethylphenanthridizinium Perchlorate	a	238,274,279,333 sh,348,364 (4.48;4.37;4.42;3.71;4.05;4.18)		15
7,10-Dimethylphenanthridizinium bromide	a	225,242,285,329,345,363	229.5;272,332,333,352	29
3,7-Dimethylphenanthridizinium Perchlorate	a	230 sh,238,259,269,278 324,339,356 (4.45;4.50;4.30;4.36; 4.32;4.37;4.06;4.19)	255,262,275,298 sh, 317,330,347 (4.28;4.30;4.31;3.89; 3.70;3.70;3.79)	21
7,9-Dimethylphenanthridizinium Bromide	a	227,240,273,325,341,357		22
7,11-Dimethylphenanthridizinium Bromide	a	239,285,332,347,364		22
2,7-Dimethylphenanthridizinium perchlorate	a	223,237,255 sh,268,277 324,339,356 (4.42;4.50;4.28;4.34; 4.40;3.76;4.08;4.17)	227,262,272,316,328, 349 (4.40;4.26;4.33; 3.62;3.71;3.82)	21
2,7,10-Trimethylphenanthridizinium perchlorate	a	226,243,282,330,346,362 (4.46;4.57;4.36;3.70; 4.04;4.16)	230,269,320,354	21

Compound	Solv.	Absorption maxima max nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
2,7,11-Trimethylphenanthridizinium perchlorate	a	227 sh,240,283,330,345,362 (4.44;4.55;4.49;3.75; 3.98;4.06)	258,322,334,353 (4.07;3.70;3.73;3.86)	21
9-tert.butyl-7-methylphenanthridizinium perchlorate	a	225,237,271,300,322,337,335 (4.44;4.12;4.39;3.84;3.84; 3.84;4.08;4.20)	205,229,253,315,327,344 (4.05;4.36;4.24;3.76 3.76;3.82)	21
1,3-Dimethylphenanthridizinium perchlorate	a	265 sh,273,280,332,346,363 (4.42;4.43;3.79;4.08;4.24)		19
1,3-Diphenylphenanthridizinium perchlorate	a	255 sh,275 sh,393,360,375 (4.46;3.96;4.16;4.23)		19
8,9-Dibenzoxyphenanthridizinium perchlorate	a	275 sh,281,310 sh,323,338, 355 (4.46;3.96;4.16;4.23)		19
8,10-Dibenzoxyphenanthridizinium perchlorate	a	283,303,327,345,361 (4.34;4.18;4.09;3.82;3.88)		19
7-Methylbenzo(k)phenanthridizinium perchlorate	a	204,227,259,308,351,369, 388 (4.41;4.41;4.45;4.42;4.00; 4.02;4.09)		15
3,7-Dimethylbenzo(k)phenanthridizinium perchlorate	a	213,241,273,321,349,368,387 (4.11;4.50;4.72;4.42;3.73; 3.99;4.12)		15
5-Methylbenzo(i)phenanthridizinium perchlorate	a	231,243,271,318,348,368,387 (4.36;4.42;4.66;4.45;3.73; (3.99;4.08)		15
5,9-Dimethylbenzo(i)phenanthridizinium perchlorate	a	213 sh,241,273,321,349, 368,387 (4.11;4.50;4.72;4.47;3.73; 3.99;4.12)	253,295,343,357,377 (4.45;4.19;3.69; 3.67;3.84)	15
1-Hydroxy-7-methylphenanthridizinium perchlorate	a	230,283,309,342,357,375	256,304,331,345,365	27

Compound	Solv.	Absorption maxima max. nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
11-Hydroxy-2,3,9,10-tetramethoxyphenanthridizinium perchlorate	b	220,240 sh,244,275 sh, 305,312,337 (4.05;4.12;4.13;4.12 4.34;4.33;4.08)	367 sh,415,438 (3.71;3.69;3.78)	27
2,3-Methylenedioxy -12-methoxy-9-methylbenzo(a)phenanthridizinium perchlorate	b	226,245,284,403,424 (4.47;4.57;4.41;4.42;4.44)	232,260,343,409 (4.39;4.35;3.43;4.20)	24
14-Methoxy-11-methyldibenzo(a,c)-phenanthridizinium perchlorate	b	228,257,292,430 (4.36;4.57;4.52;4.07)	225,231,282,355 (4.35;4.39;4.46;3.58)	24
13,14-Dimethoxy-11-methyl(a,c)-phenanthridizinium perchlorate	b	229,256,292,414 (4.45;4.57;4.59;4.19)	223,239,266,323 (4.39;4.41;4.46;3.72)	24
7-(β-Carboxyethyl)phenanthridizinium perchlorate	b	228,242,274,325,340,355 (1.42;4.44;4.48;3.48; 3.84;4.07;4.20)	232,256,318,330,347 (4.36;4.33;3.76;3.77;3.83)	16
7-(β-Carboxymethyl)phenanthridizinium perchlorate	b	255,238,269,282,326,340,355 (4.32;4.40;4.30;4.34;3.67; 3.94;4.06)		16
7-(β-Carboxymethyl)-10-methylphenanthridizinium perchlorate	b	228,243,263,285,332 sh, 347,362 (4.38;4.54;4.35;4.39; 3.56;3.97;4.10)	229,256,271,322,353 (4.36;4.33;4.32;3.54, 3.87)	16
BENZO(c)QUINOLIZINIUM SALTS:				
Benzo(c)quinolizinium picrate	b	227,222,300,347,364 (4.27;4.48;3.67;4.11;4.2)		23
1,2-Dimethylbenzo(c)quinolizinium fluoroborate	a	410 (20,000)		23
				23

Compound	Solv.	Absorption maxima max nm./ $\log_e$	Absorption minima max nm./ $\log_e$	Ref.
1-Methyl.2-phenylbenzo(c)-	a	398		23
quinilizinium Fluoroborate		(20,000)		
1-Methyl-2-ter.butylbenzo(c)-	a	380		23
quinolizinium Fluorobrorate		(20.000)		
1-2-Diphenyl-5-methylbenzo(c)-	a	420		23
quinolizinium Fluoroborate		(16,000)		
1,2,3,4-Tetrahydrobenzo(c) -	a	240, 312,sh, 320		25
quinolizinium Chloride		(4.43; 3.94; 3.98)		
10-Nitrobenzo(c)quinolozinium	a	252, 287, 236, 350, 368		25
Perchlorate		(3.92; 3.78; 4.04; 4.14; 4.46)		
10-Aminobenzo(c)quinolizinum	a	247, 328, 440		25
Bromide		(4.41; 4.26; 3.76)		
10-Acetamidobenzo(c) -	a	232, 240, 256, 352, 368		25
quinolizinium Bromide		(4.23; 4.25; 4.29; 3.89; 4.01)		
10 Amino-1,2,3,4-tetrahydro-	a	262, 290, 380		25
benzo(c)quinolizium		(4.38; 3.69; 4.11)		
perchlorate				
Betain of Benzo(c)quinolizinium	a	230, 256, 300 sh, 336, 350		25
Chloride		368		
		(4.18; 4.47; 3.75; 3.78; 4.03; 4.13)		

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