

Supporting Information

Multicomponent synthesis of novel β -carboline-fused imidazolium derivatives via Mannich reaction: cytotoxicity, molecular docking, and mechanistic studies as angiogenesis inhibitors

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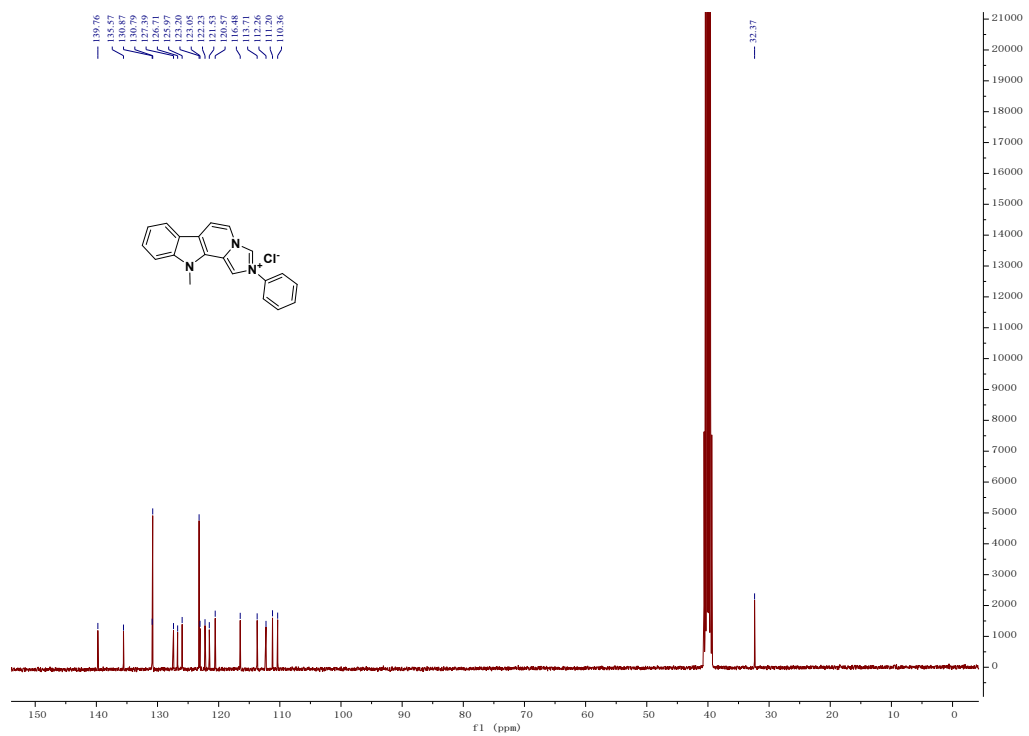
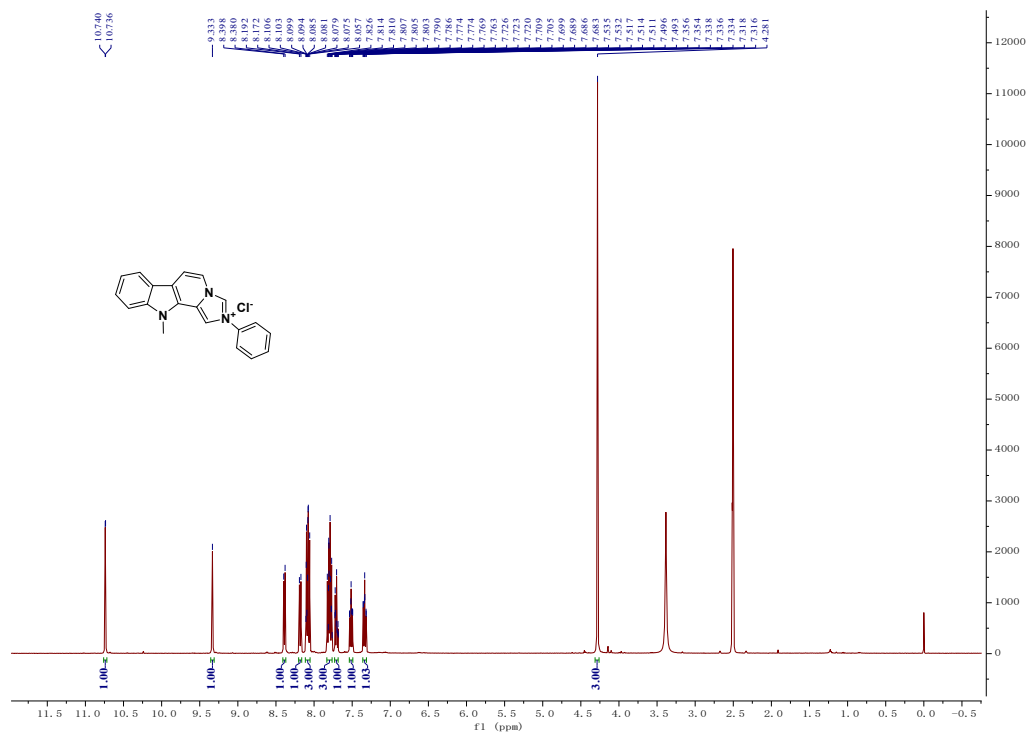
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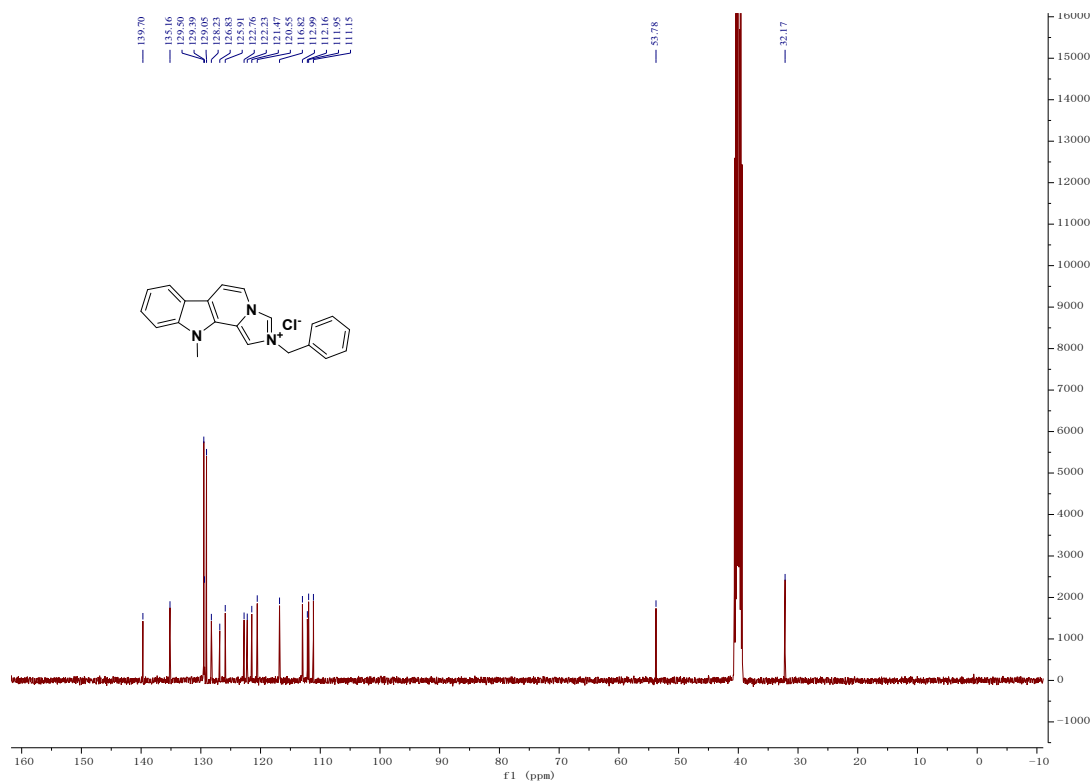
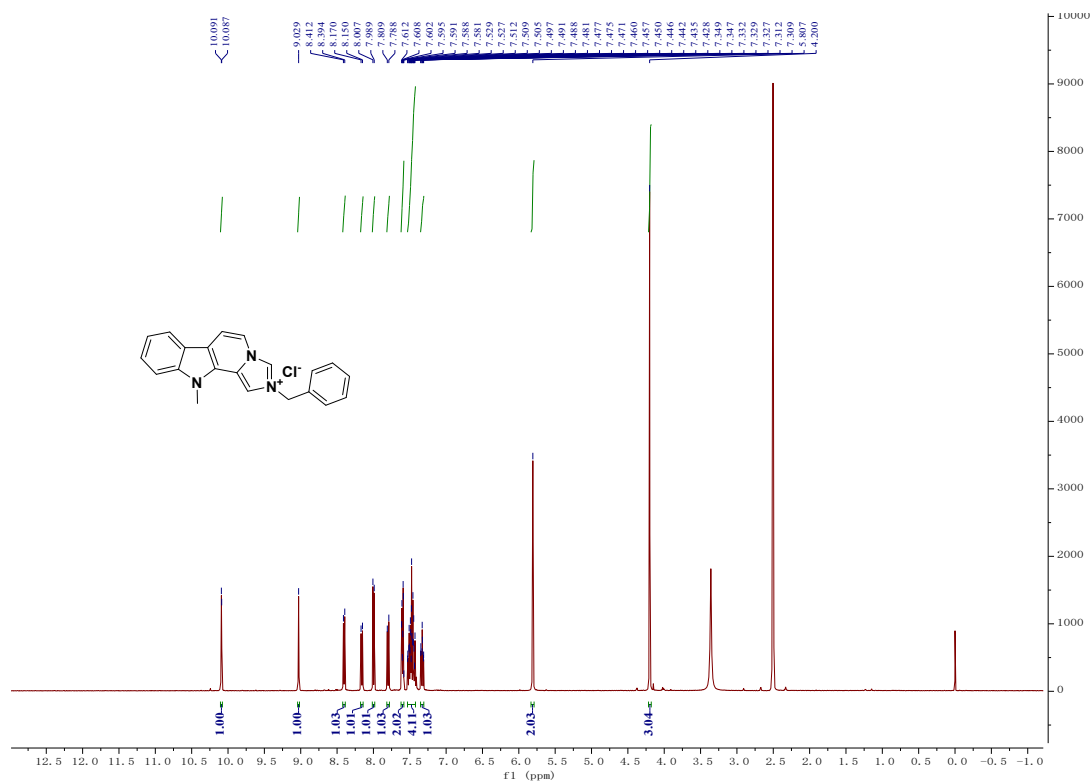
*E-mail: guoliang_xj@163.com (L. Guo), zhangjie-xj@163.com (J. Zhang)

7. NMR Spectrums of Target Compounds

11-methyl-2-phenyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3a**)



2-benzyl-11-methyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3b**)



CN1c2ccccc2n(C1=NC3=CC=CC=C3)C4=CC=CC=C4

Chemical structure: 1-methyl-2-((chloromethyl)imino)-3H-indole.

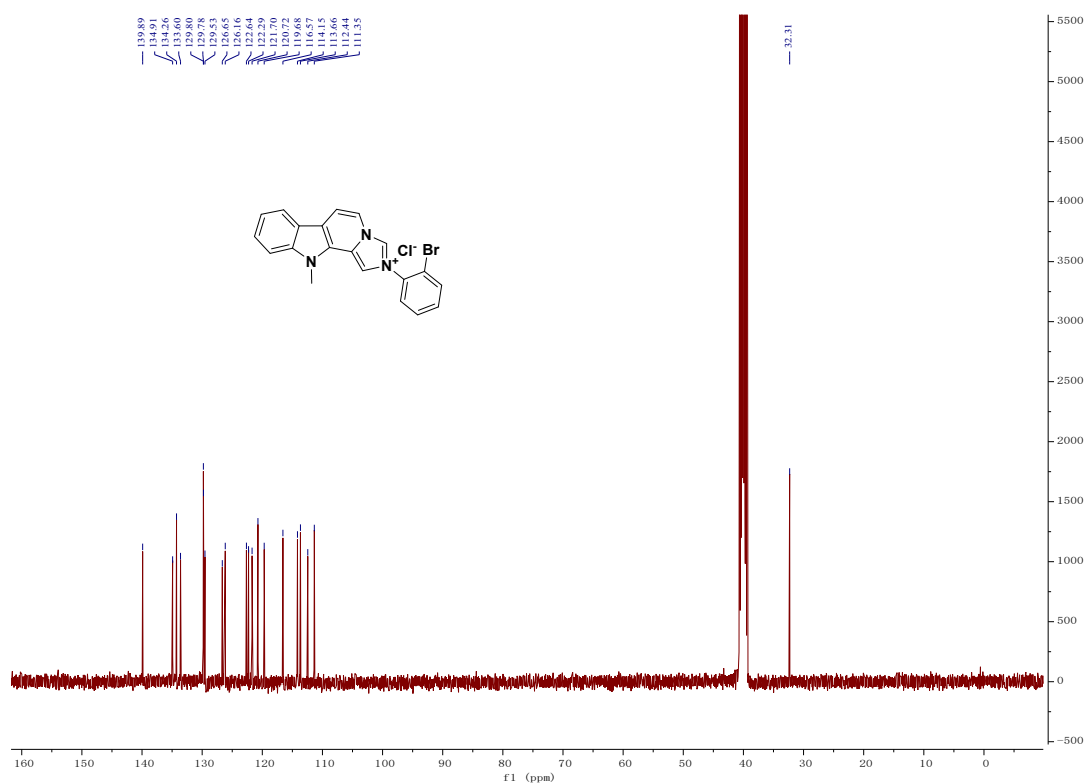
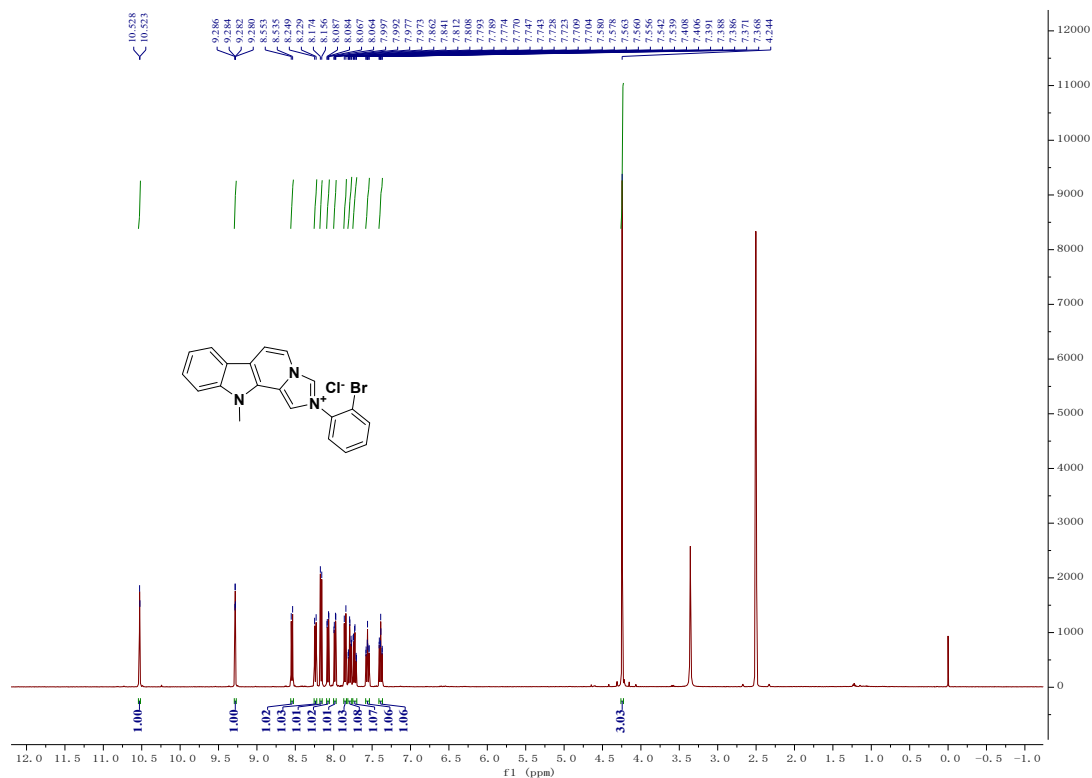
¹H NMR spectrum (CDCl₃) showing peaks in the aromatic region (7.0-9.0 ppm) and aliphatic region (2.5-4.0 ppm). The x-axis is labeled f1 (ppm) and ranges from -1.0 to 11.5. The y-axis is labeled intensity and ranges from -1000 to 14000.

Peak list (ppm): 9.982, 9.025, 8.395, 8.377, 8.152, 8.132, 7.959, 7.944, 7.796, 7.776, 7.529, 7.508, 7.512, 7.509, 7.505, 7.488, 7.351, 7.349, 7.341, 7.331, 7.329, 7.321, 7.314, 7.311, 7.307, 7.291, 7.282, 7.271, 7.267, 7.266, 7.249, 7.246, 7.238, 7.236, 4.820, 4.800, 4.191, 3.414, 3.395, 3.377.

Integration values: 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 2.00, 3.00, 2.01.



2-(2-bromophenyl)-11-methyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride
(3d)



Chemical structure: Cn1cnc2c1nc3ccccc3n2C4=CC=CC=C4Br

¹H NMR spectrum (ppm):

- 10.052, 10.048 (broad singlet, integration 1.00)
- 9.023, 9.021, 9.019, 9.017 (broad singlet, integration 1.00)
- 8.450, 8.431, 8.411, 8.152, 8.052, 8.004, 7.785 (multiplet, integration 1.00)
- 7.530, 7.527, 7.524, 7.521, 7.513, 7.509, 7.506, 7.502, 7.492, 7.489, 7.486, 7.484, 7.472, 7.443, 7.435, 7.423, 7.420, 7.416, 7.408, 7.400, 7.380, 7.332, 7.330, 7.328, 7.310, 5.910, 4.184 (multiplet, integration 2.01)
- 6.01 (singlet, integration 2.01)
- 4.3 (small peak, integration 0.03)
- 3.01 (singlet, integration 3.01)
- 3.4 (small peak, integration 0.03)
- 2.5 (multiplet, integration 1.00)
- 1.0 (multiplet, integration 1.00)
- 0.0 (TMS, integration 1.00)



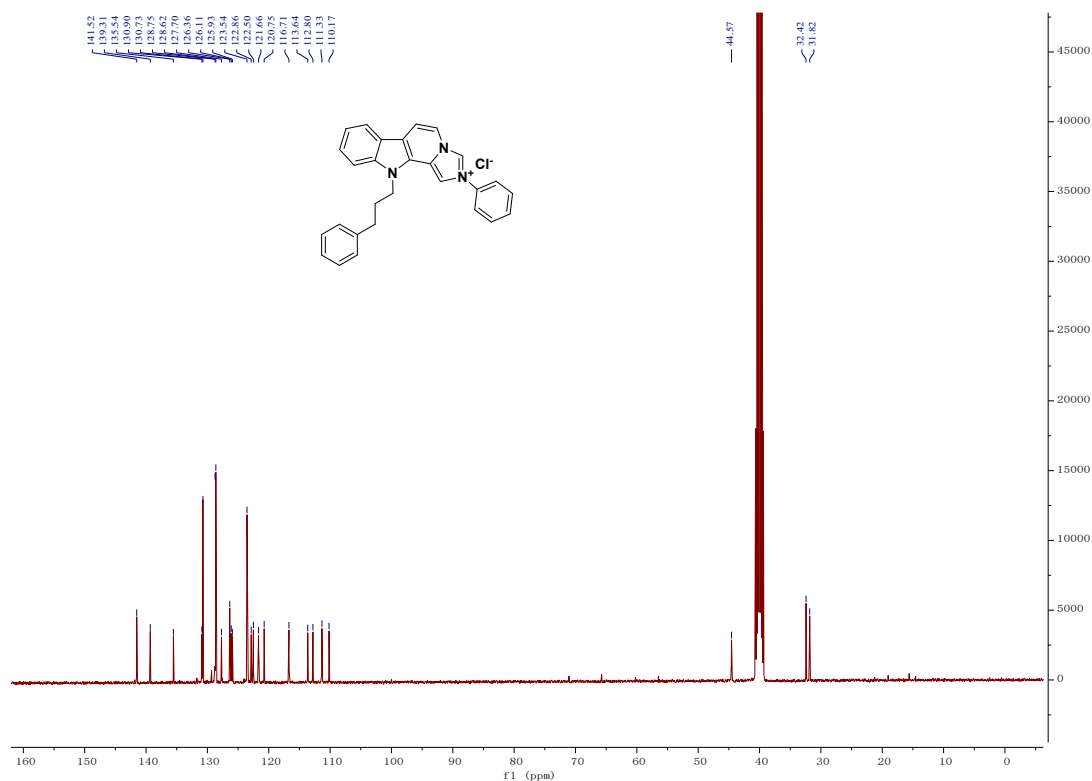
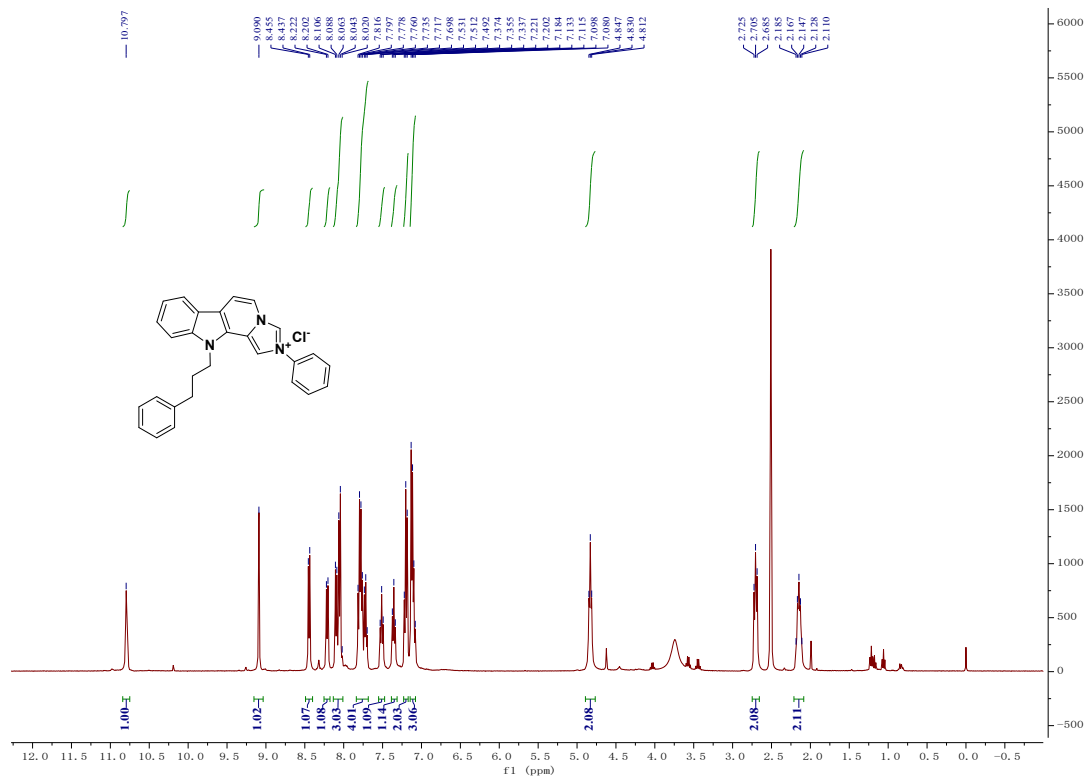
Chemical structure of compound 10: Cc1cccc2c1c(c3ccccc3n2)C#CCN(C)CCc4ccccc4Br (Note: The structure in the image is a 2-methyl-1H-indole-3-yl group attached to a 2-(2-bromophenyl)ethyl group, with a chloride counterion).

¹H NMR spectrum (CDCl₃) of compound 10. The x-axis represents the chemical shift in ppm (f1), ranging from -0.5 to 11.0. The y-axis represents intensity, ranging from 0 to 3500. The spectrum shows several peaks, with integration values provided below the baseline.

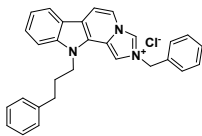
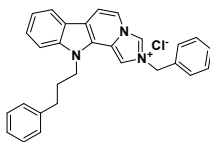
Integration values (from left to right): 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 2.04, 3.00, 2.05.



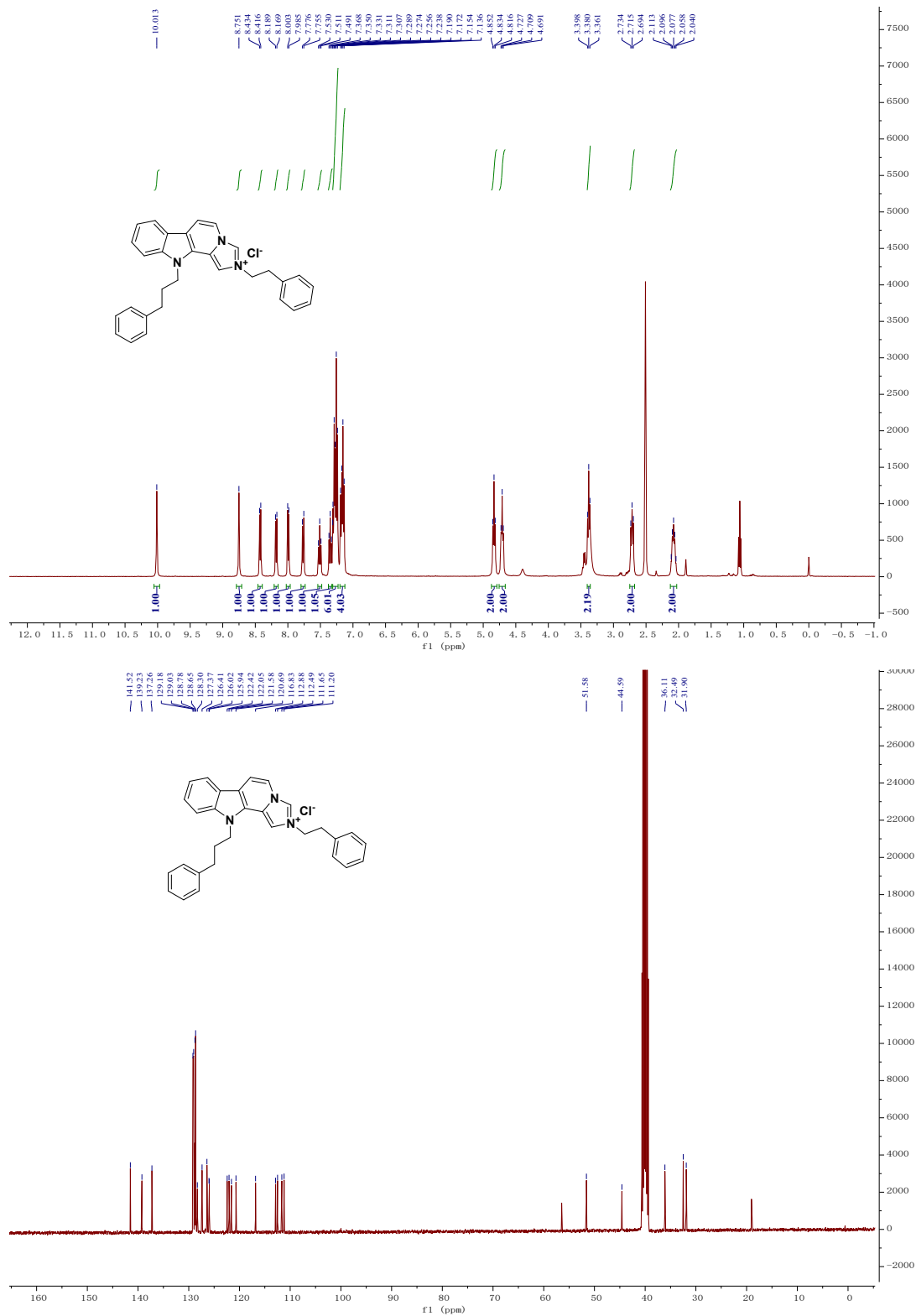
2-phenyl-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride
(3g)



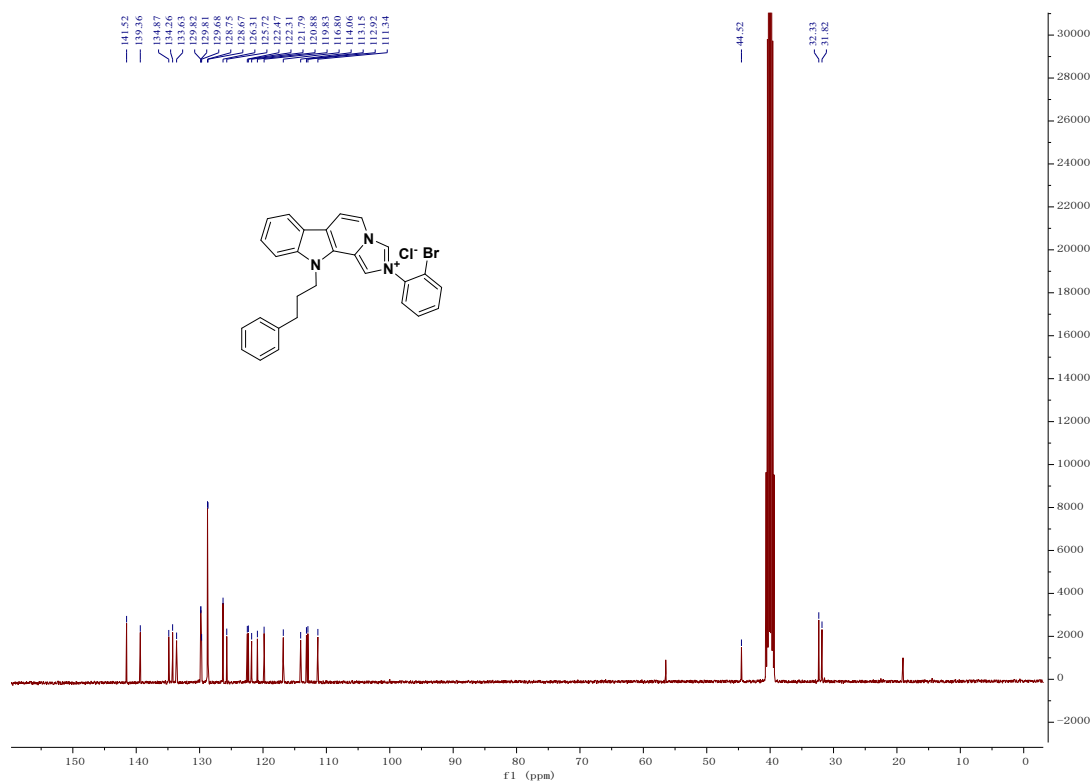
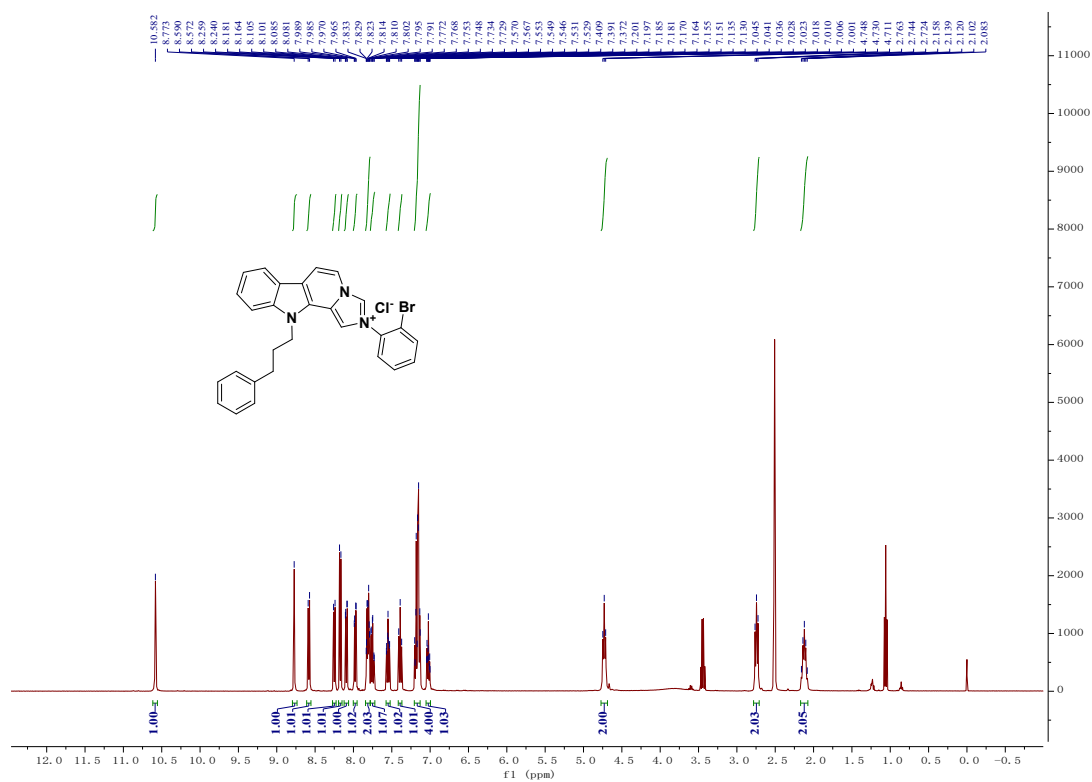
(3h)



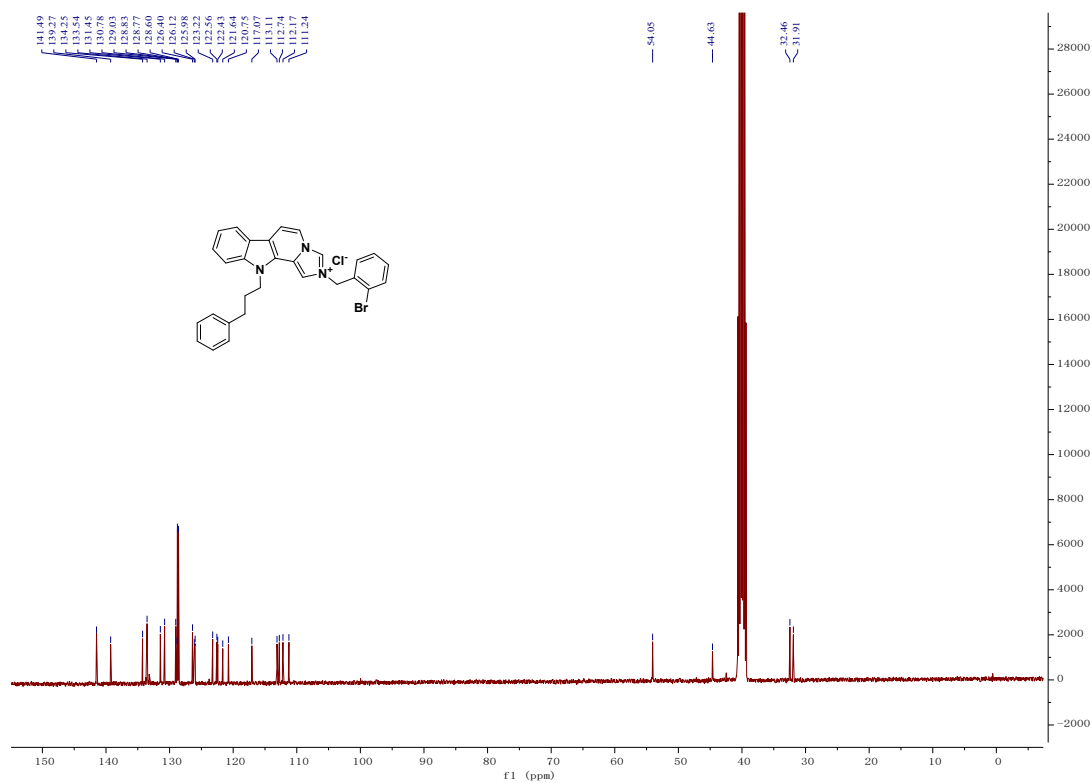
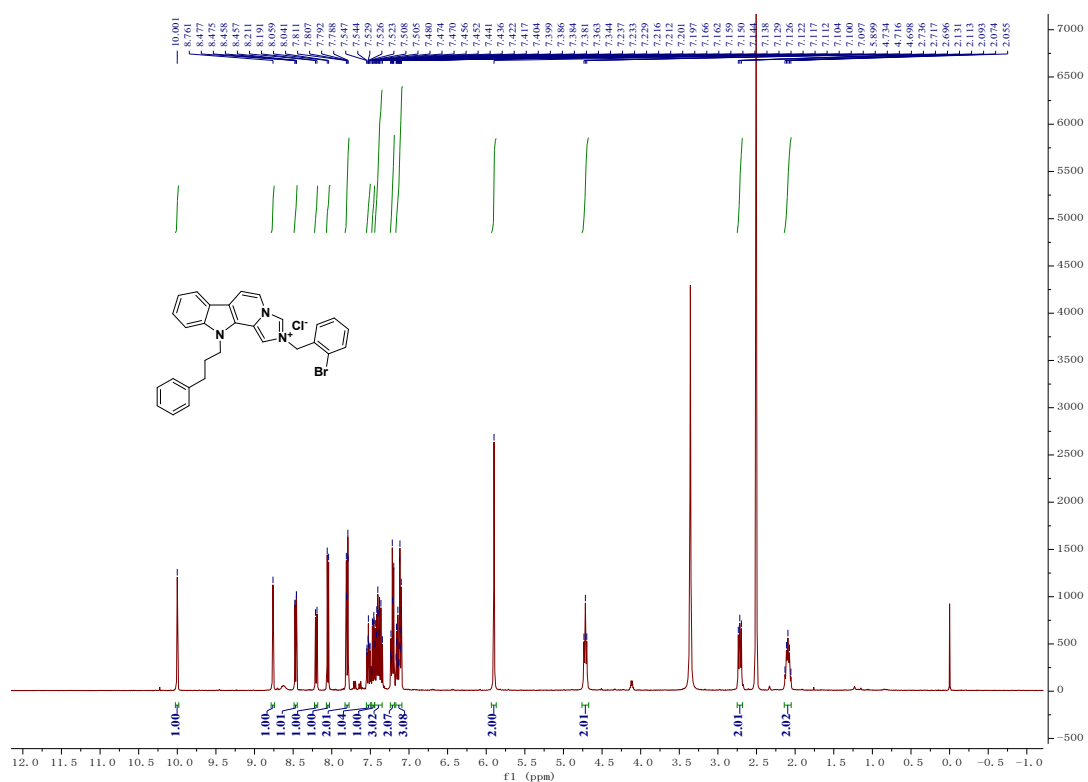
2-phenethyl-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (3i)



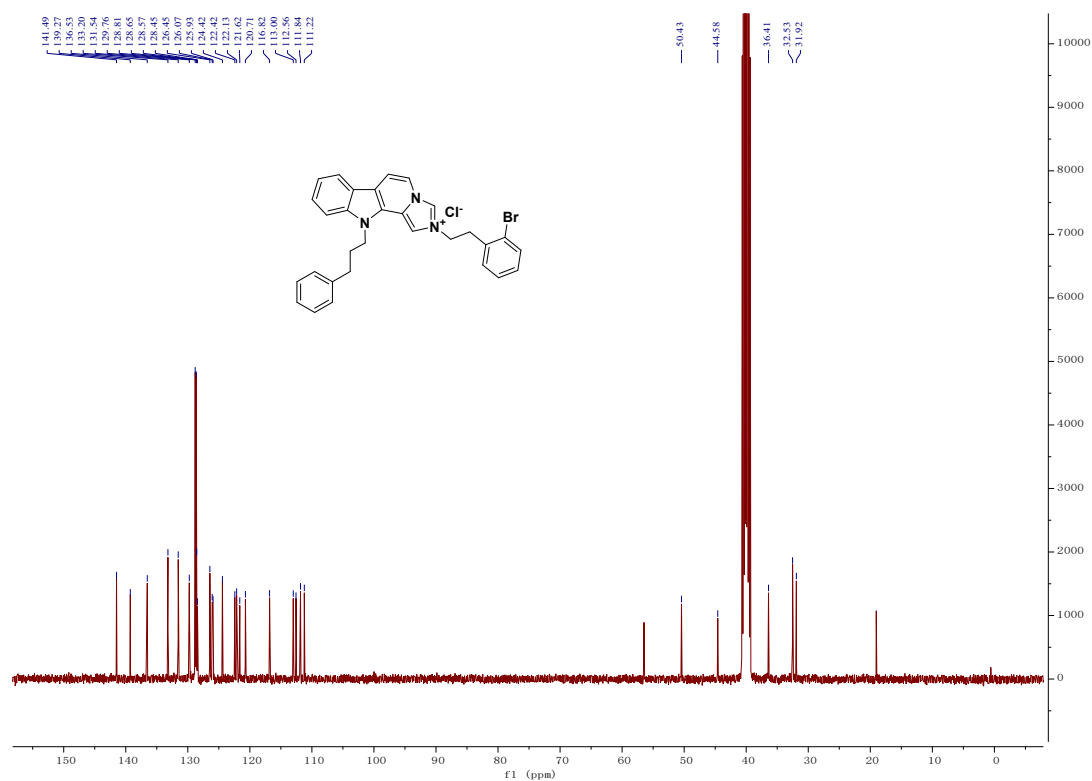
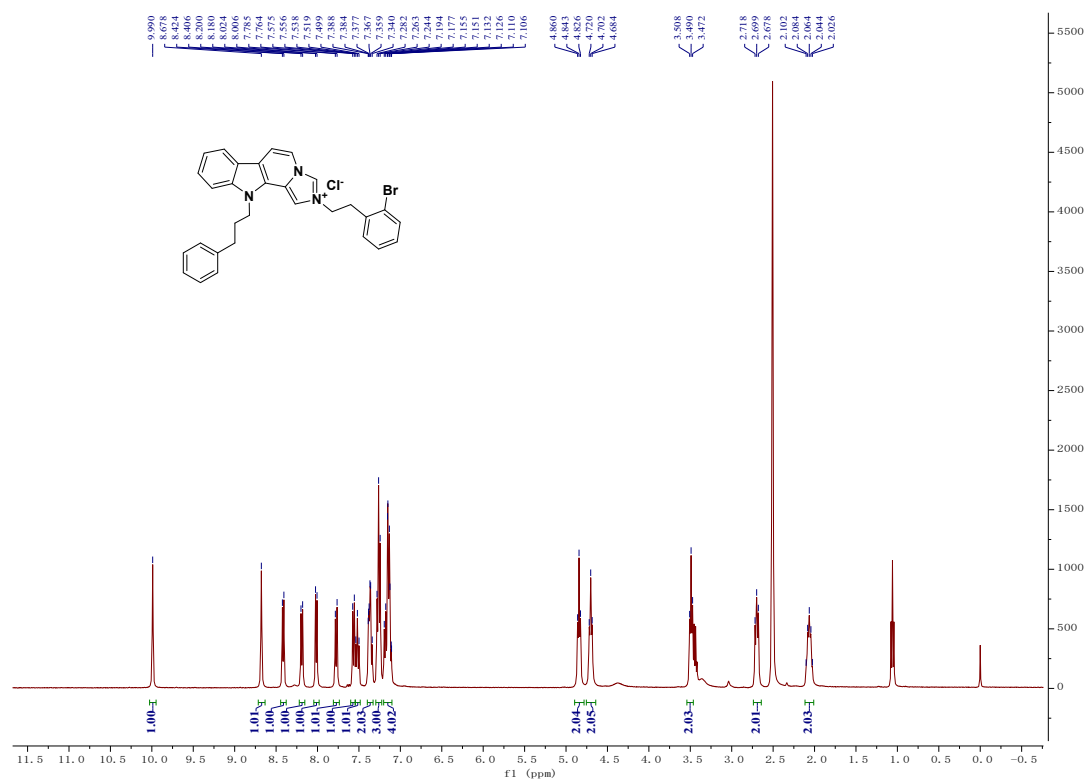
2-(2-bromophenyl)-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (3j**)**



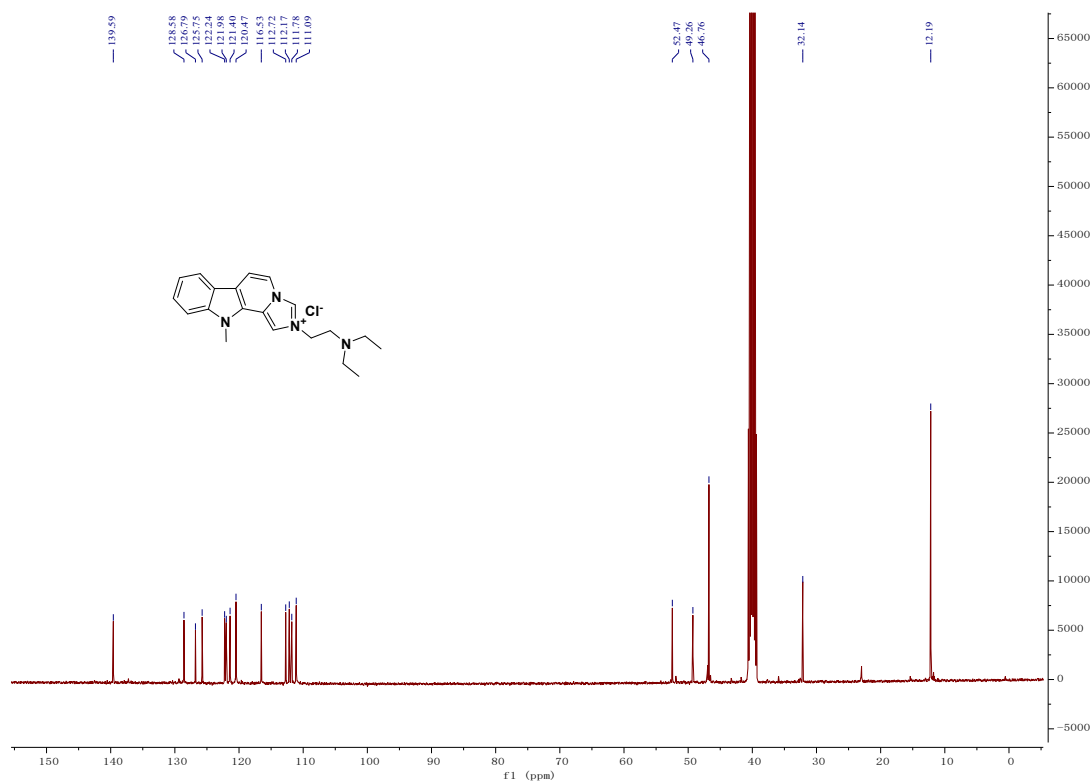
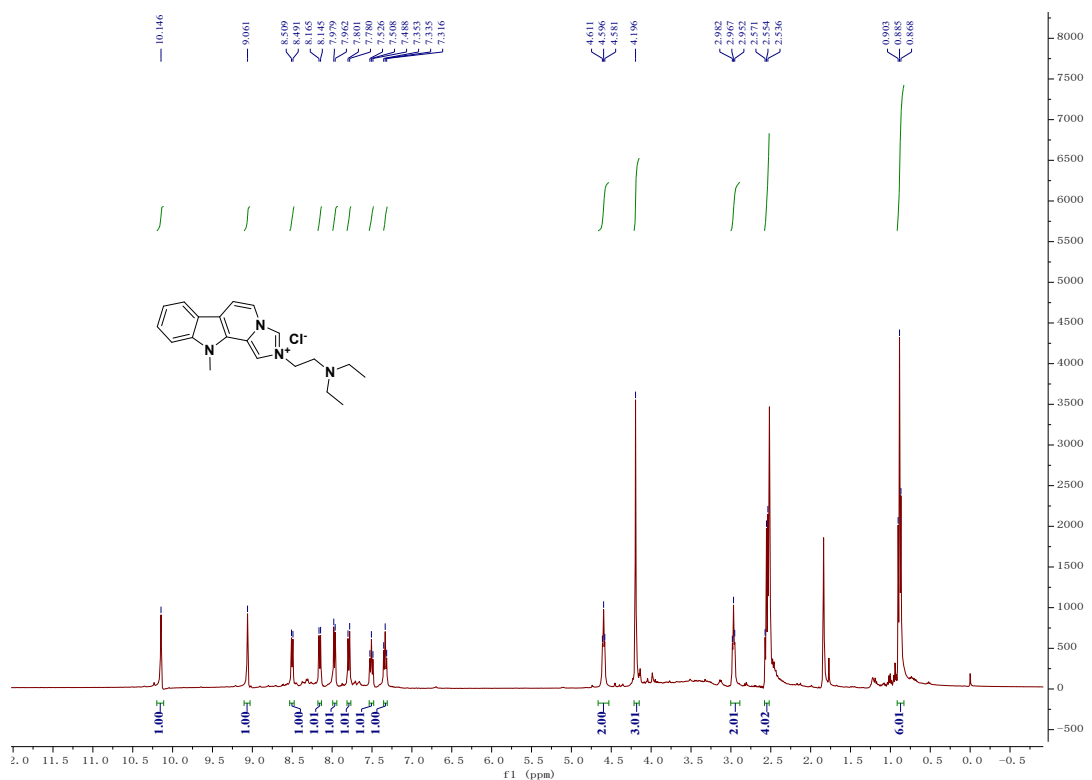
2-(2-bromobenzyl)-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3k**)



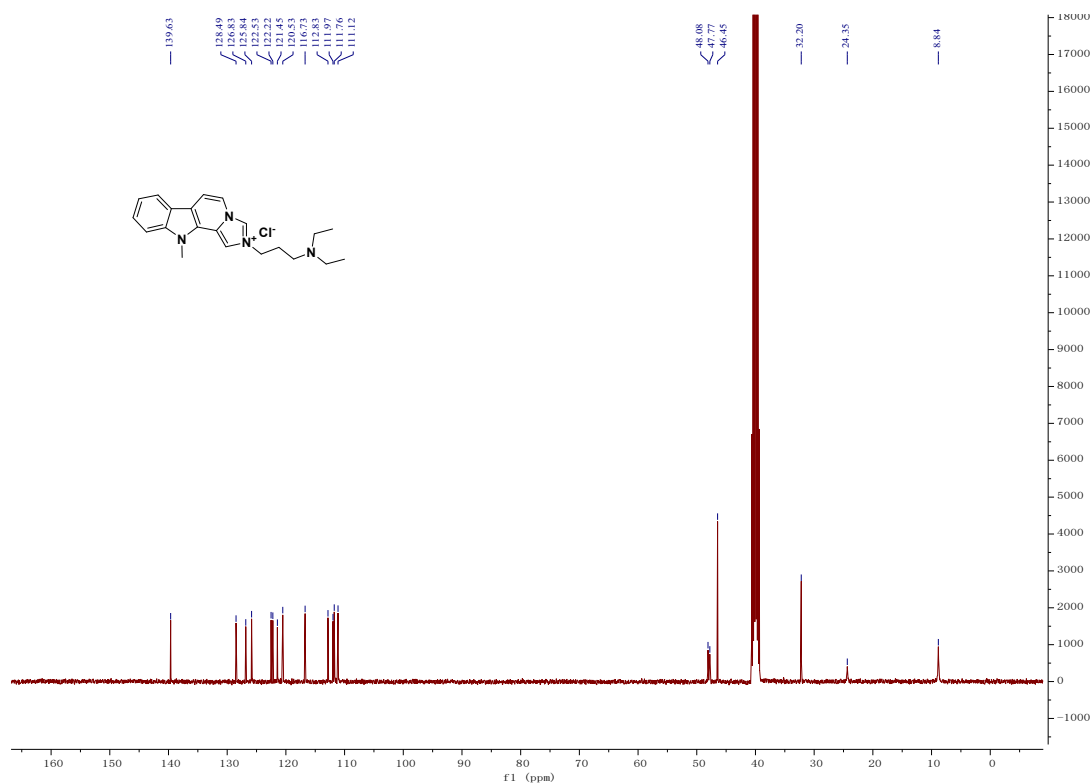
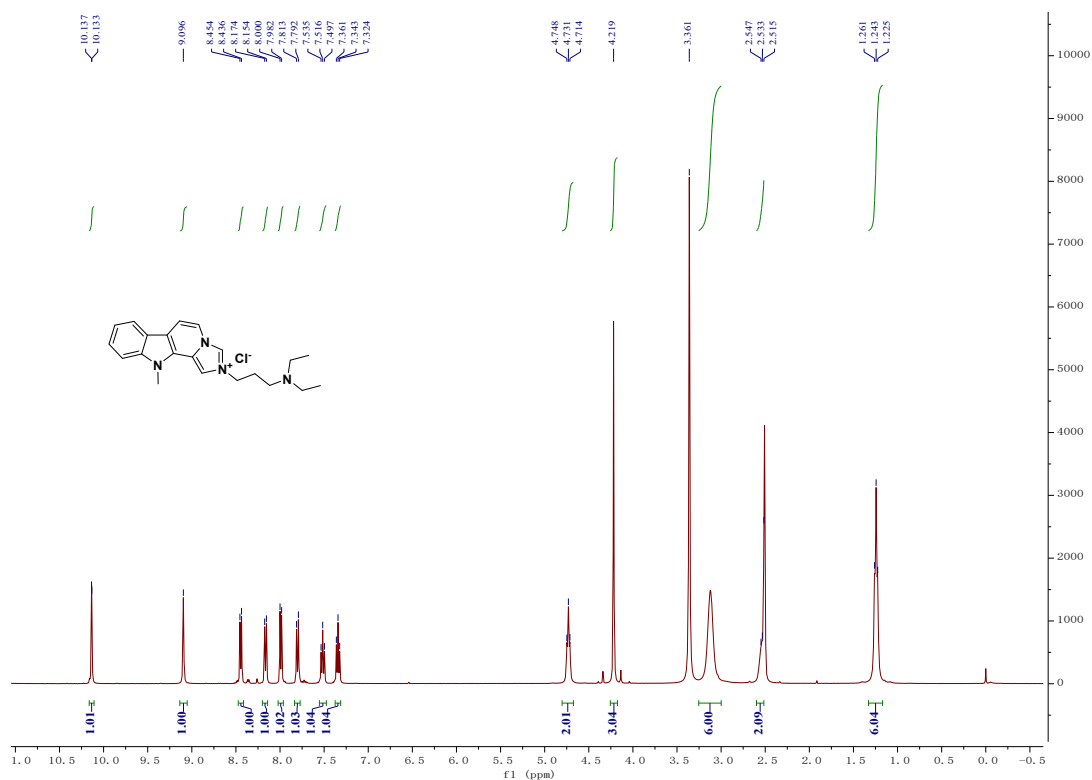
2-(2-bromophenethyl)-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (31)



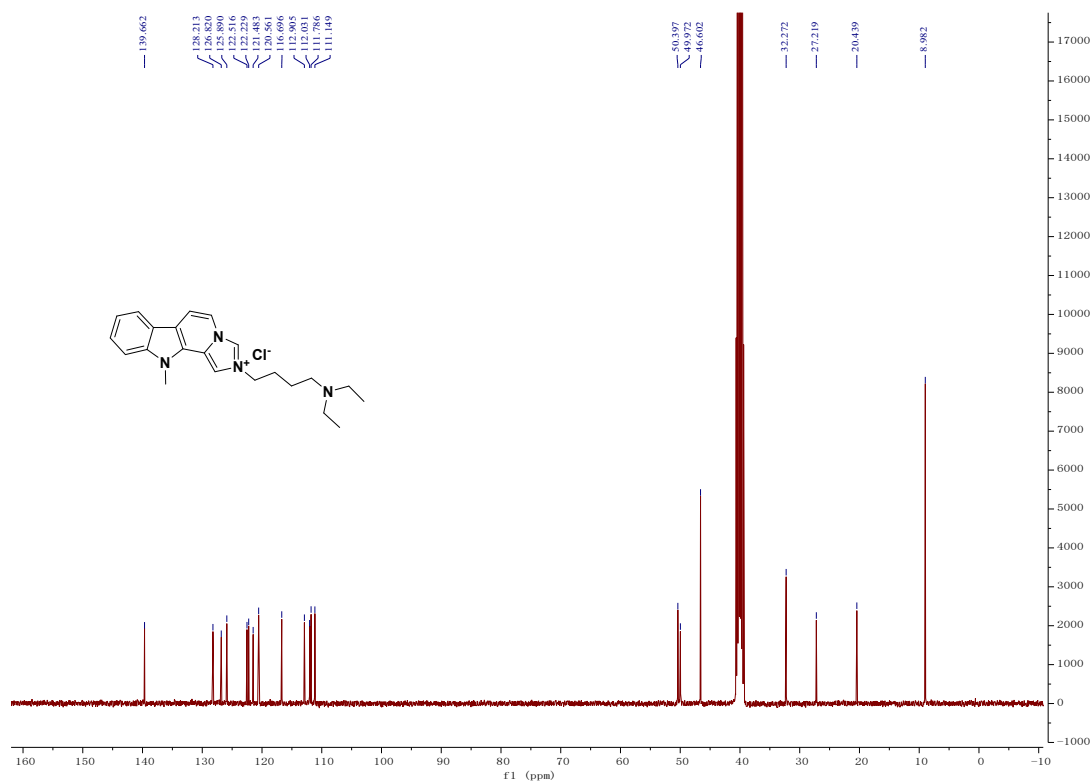
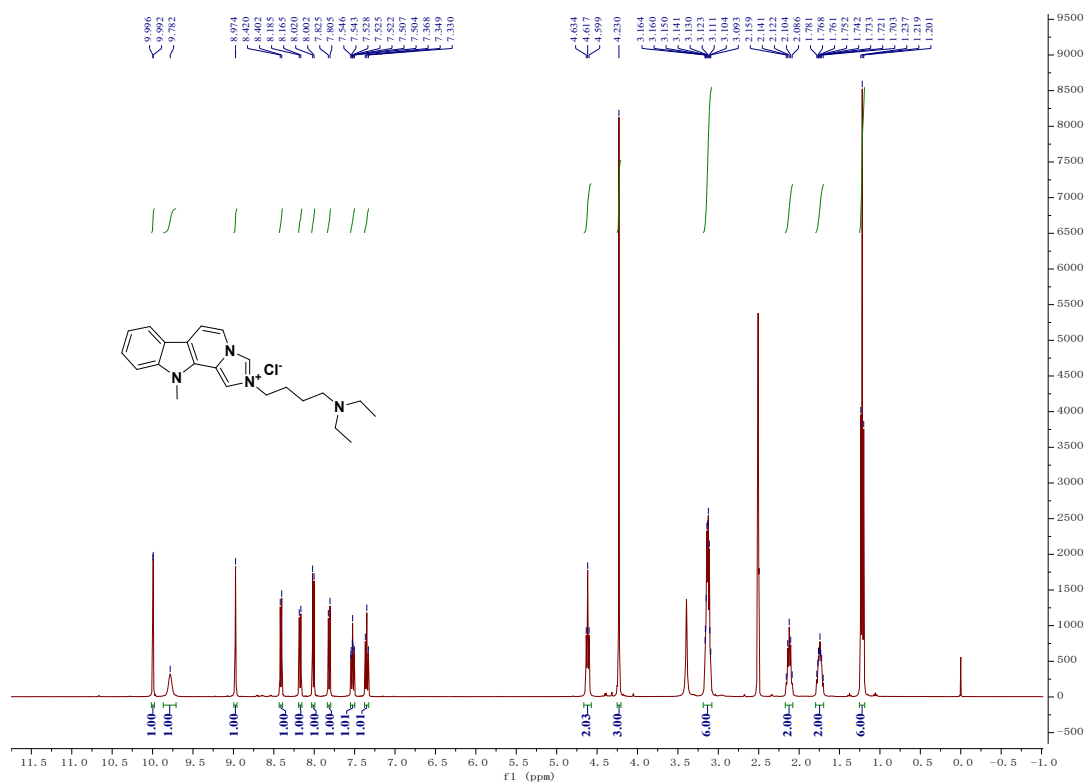
2-(2-(diethylamino)ethyl)-11-methyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3m**)



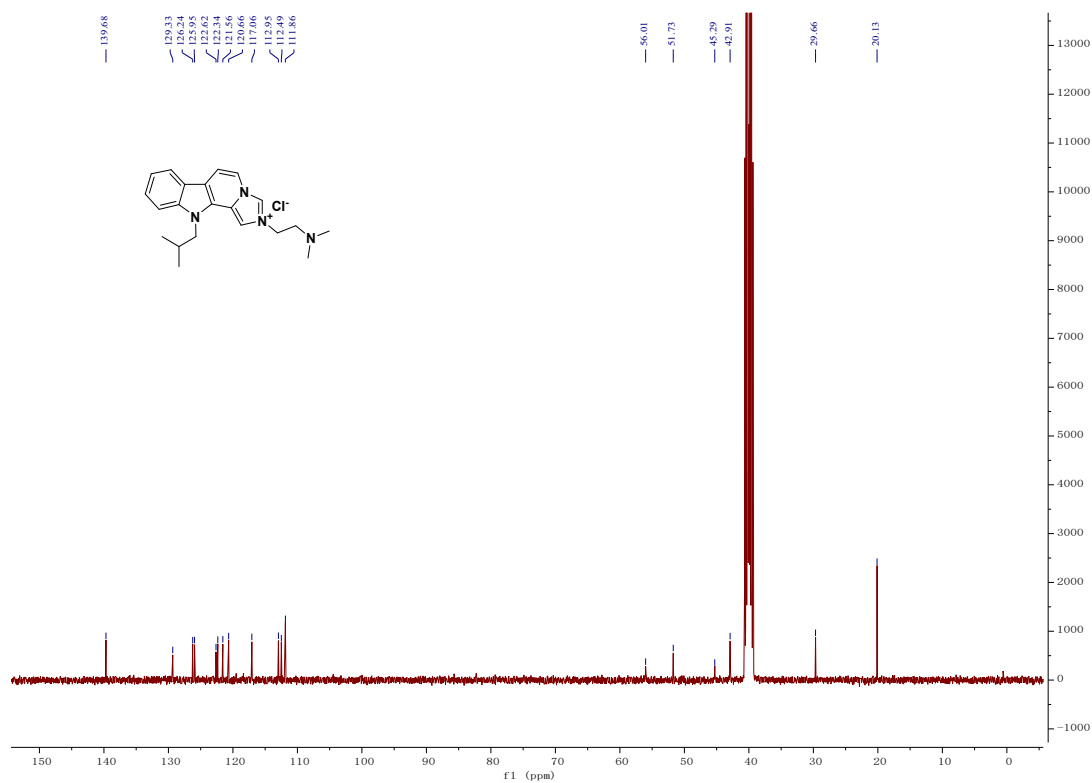
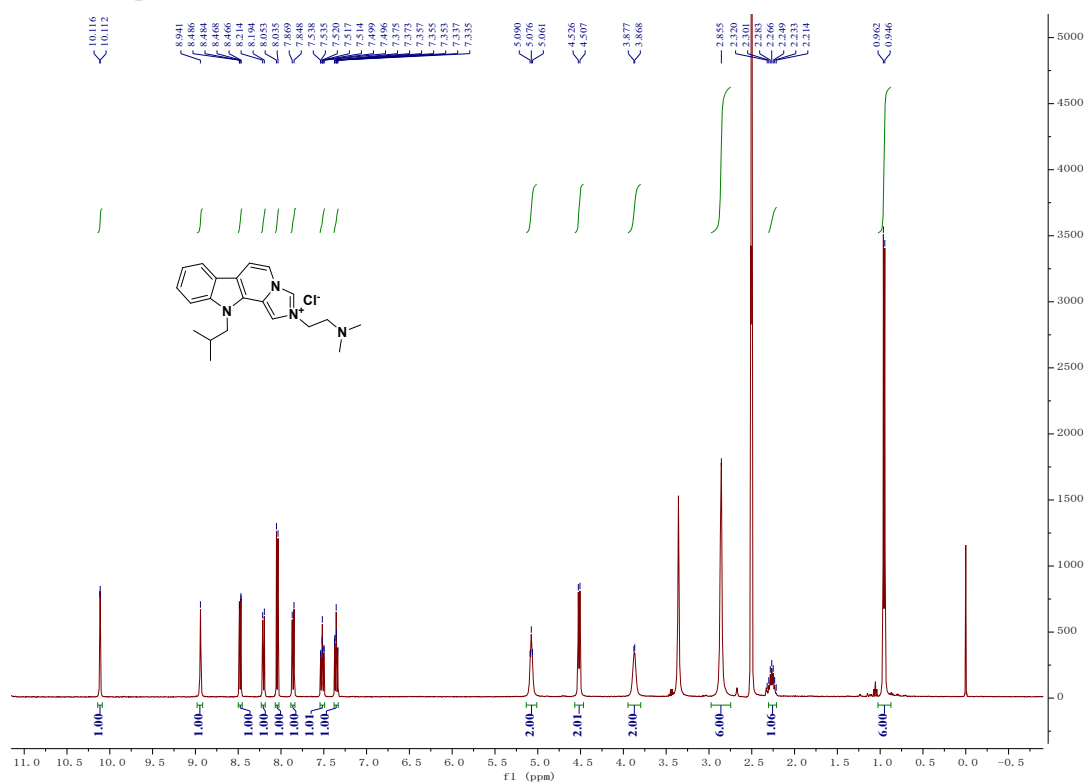
2-(3-(diethylamino)propyl)-11-methyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3n**)



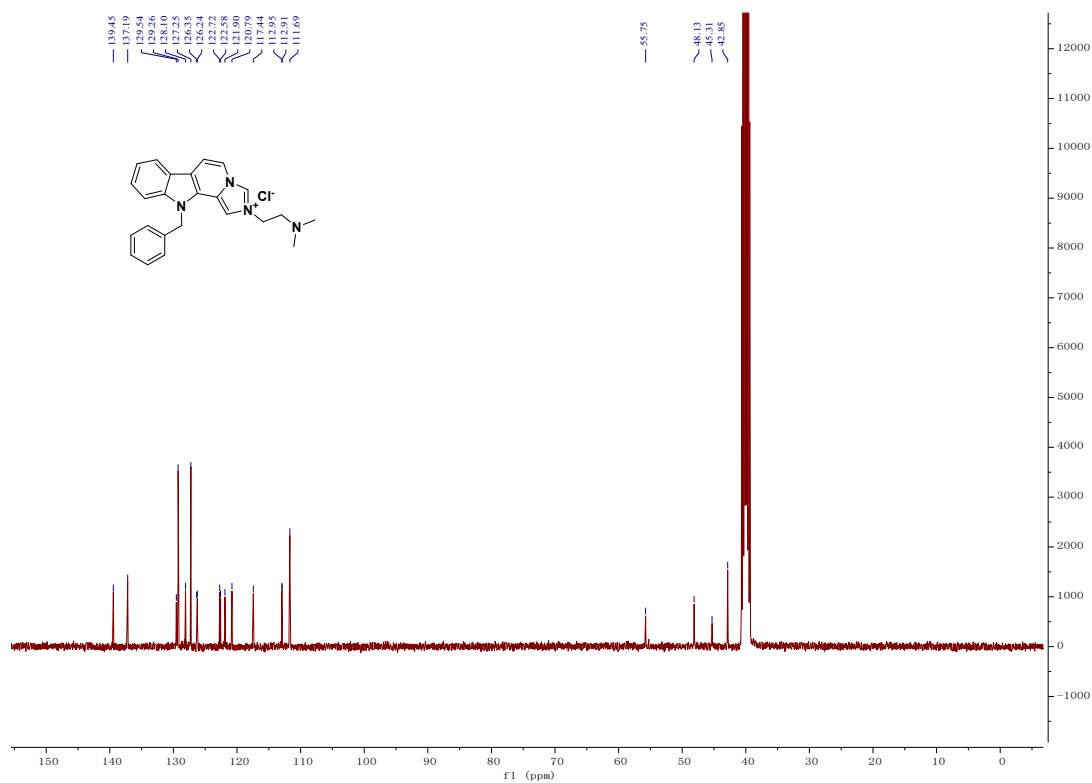
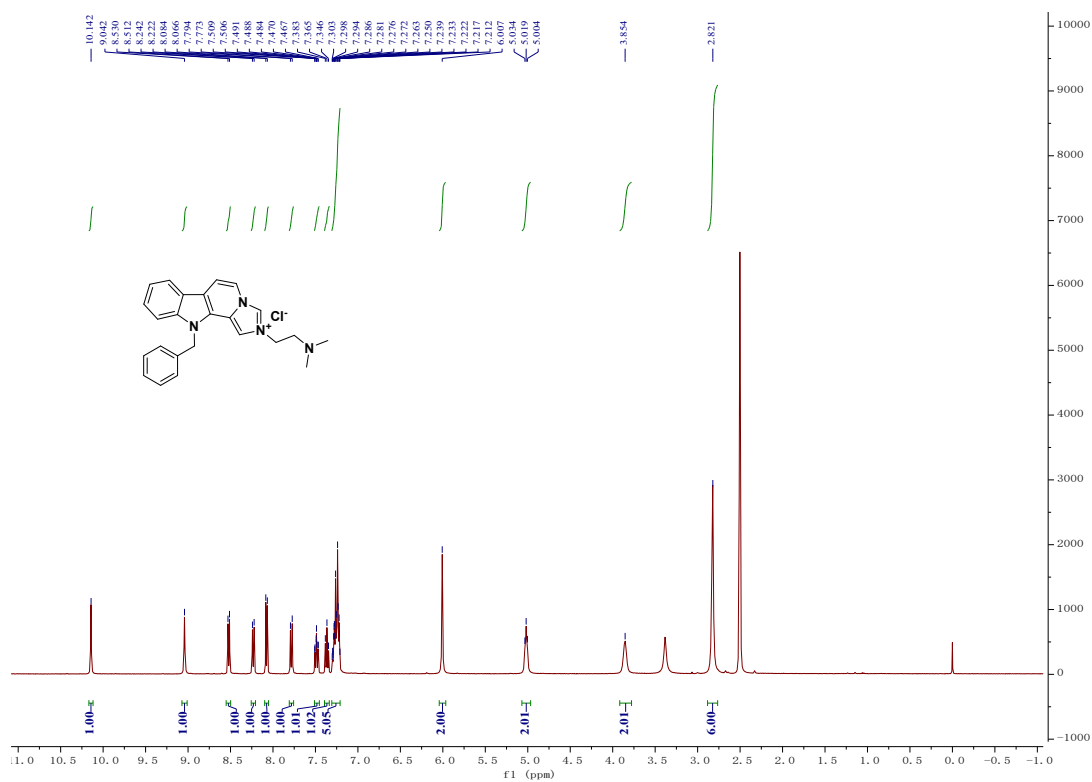
2-(4-(diethylamino)butyl)-11-methyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (3o)



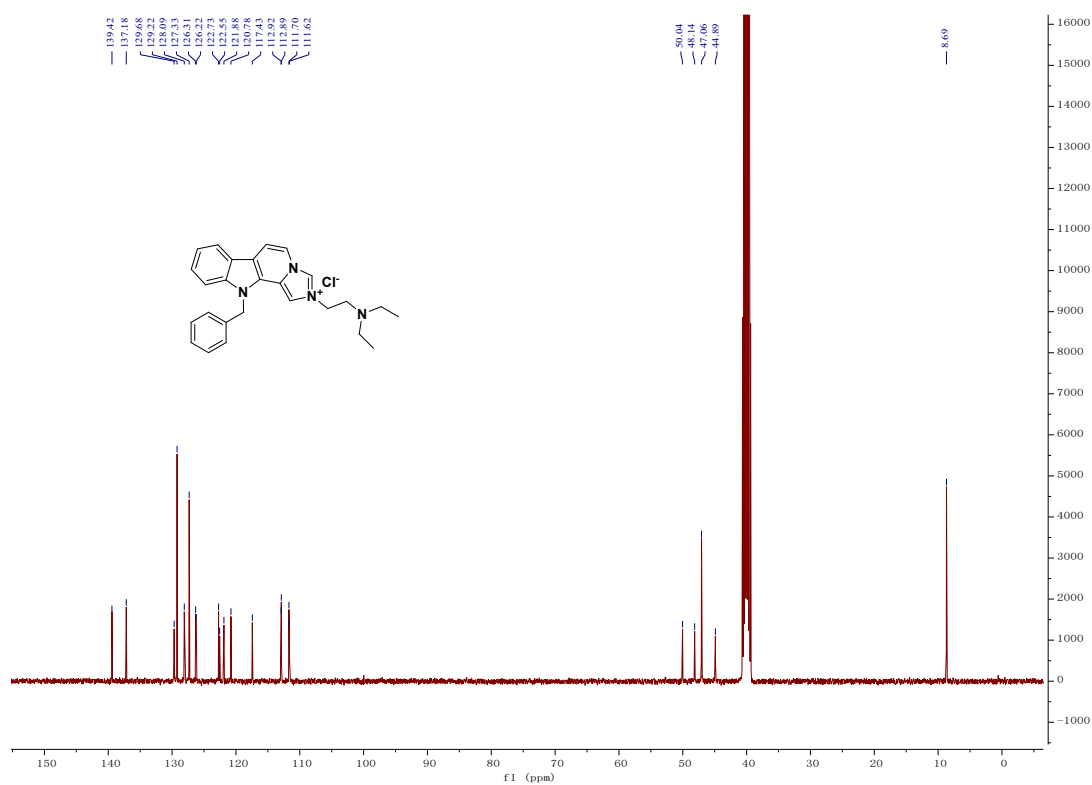
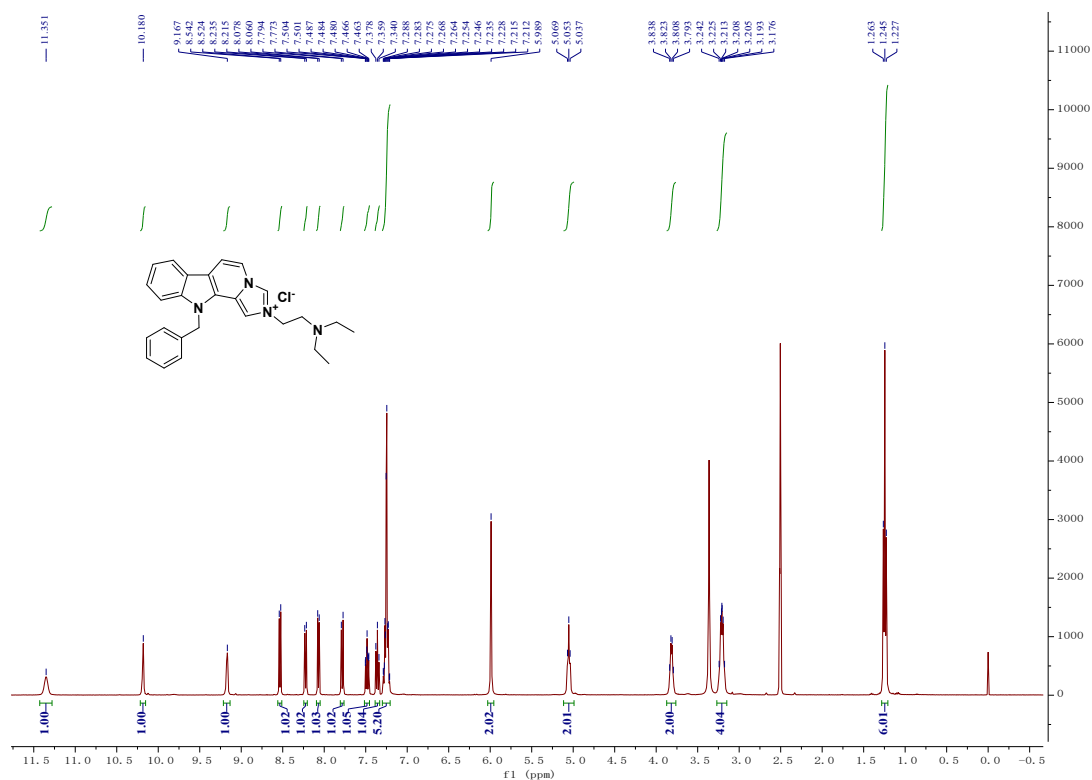
2-(2-(dimethylamino)ethyl)-11-isobutyl-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3p**)



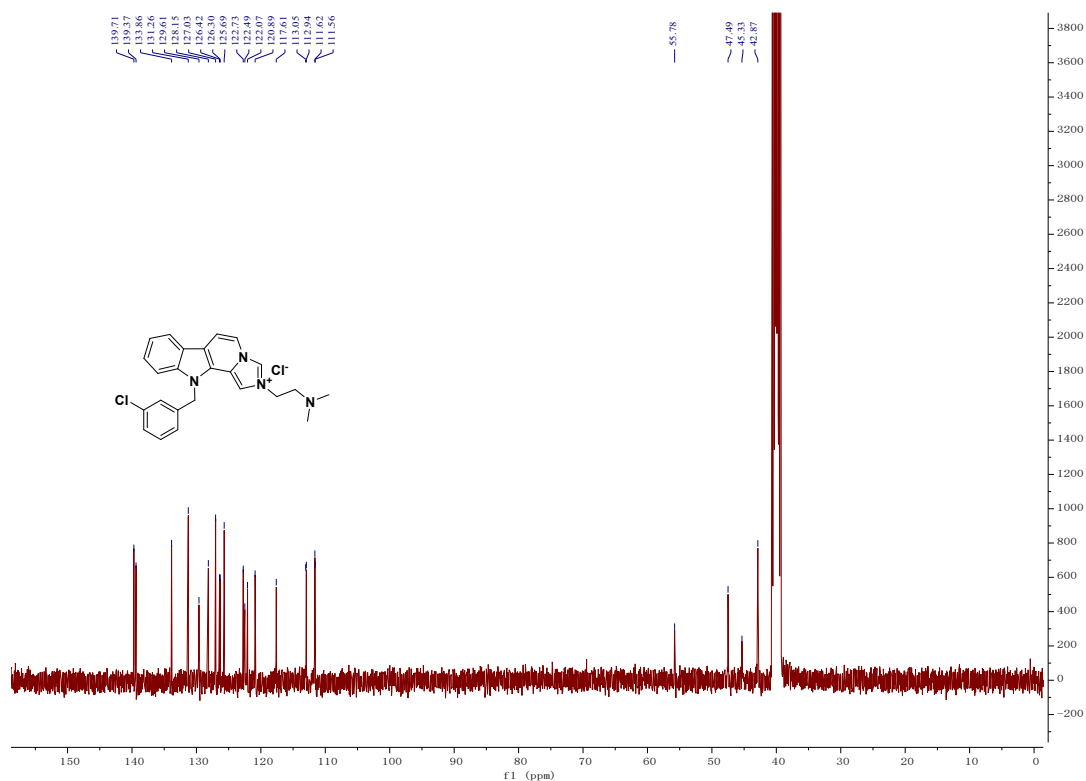
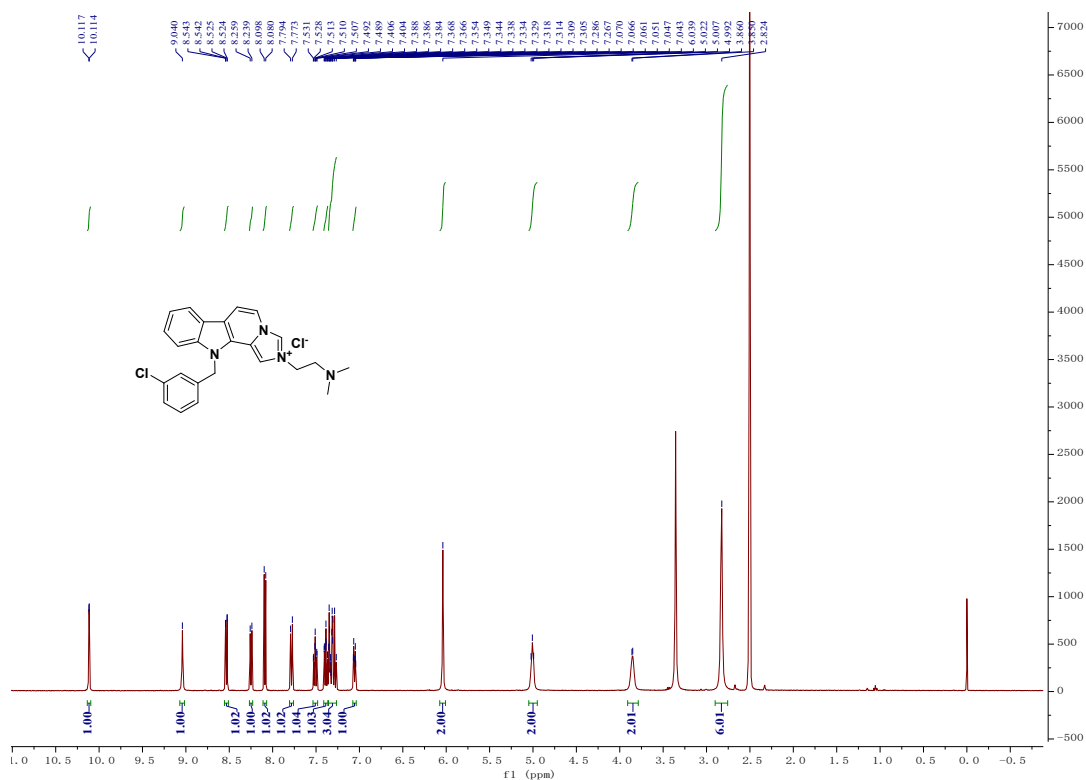
11-benzyl-2-(2-(dimethylamino)ethyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (3q)



11-benzyl-2-(2-(diethylamino)ethyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (3r)



*11-(3-chlorobenzyl)-2-(2-(dimethylamino)ethyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-*b*]indol-2-ium chloride (3s)*

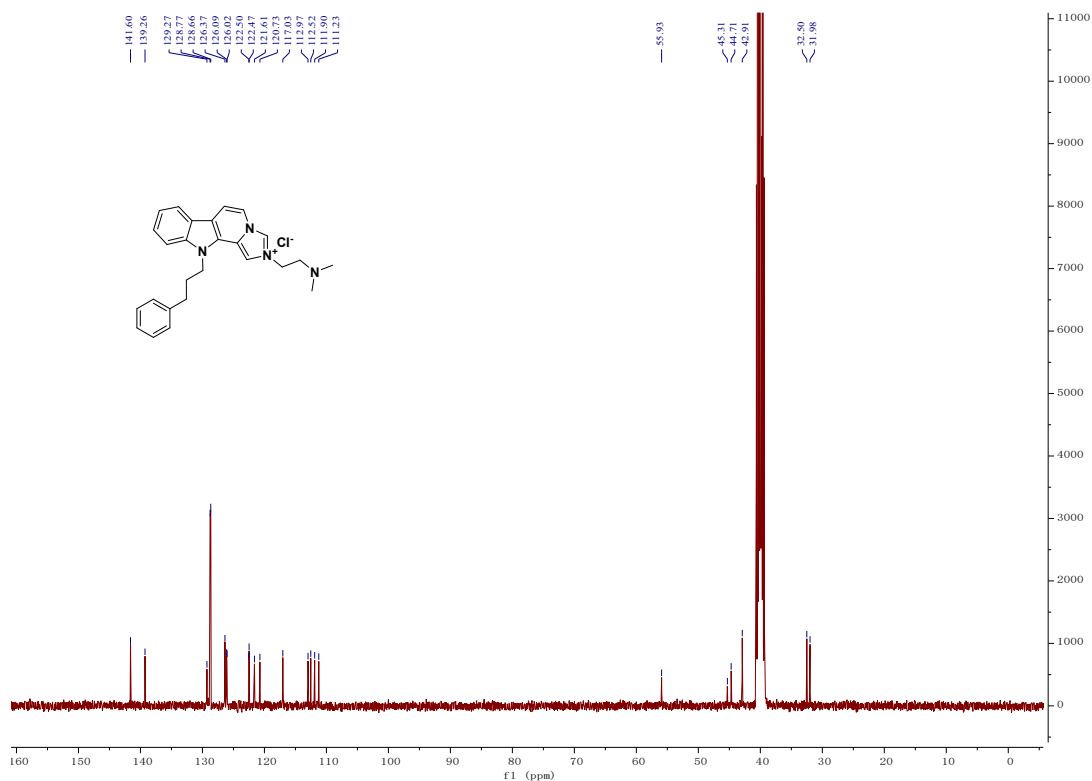
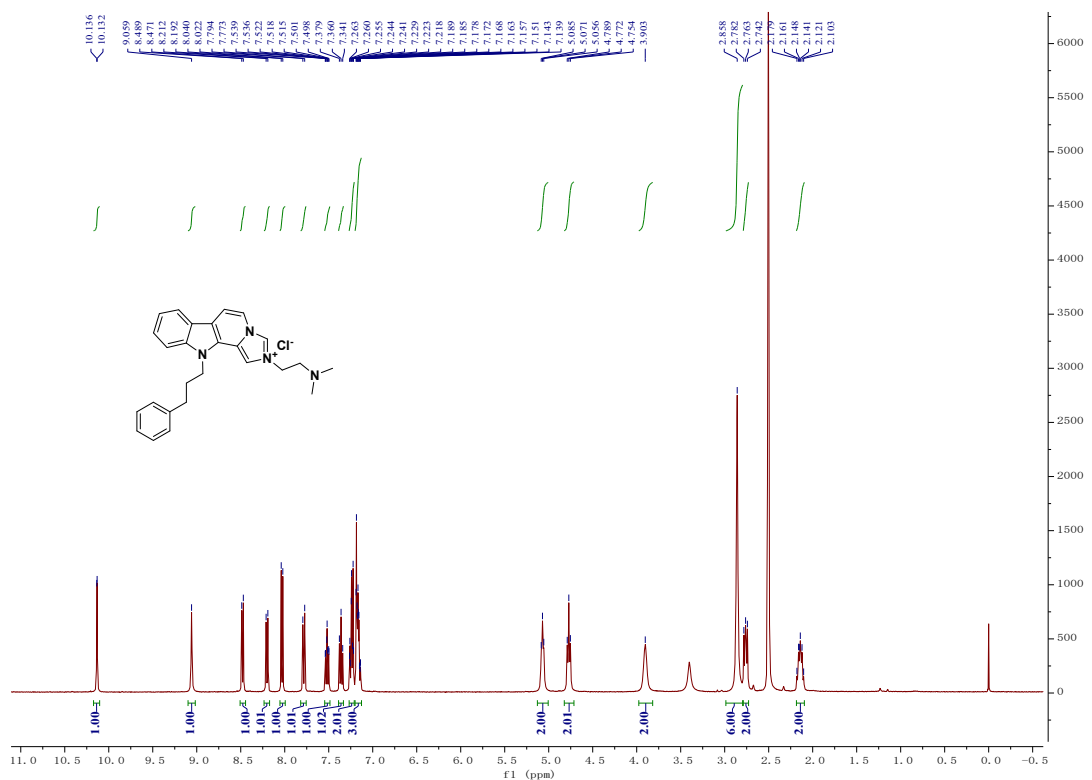


Chemical structure of compound 10 is shown as an inset. The structure is a 4-fluorophenyl group attached to the 2-position of a 1-methyl-2-((2-ethyl-1H-imidazol-1-yl)methyl)-1H-indole-3-carboxamide derivative. The NMR spectrum shows peaks for aromatic protons (7.0-8.5 ppm), the imidazole ring (7.1-7.4 ppm), the amide NH (7.1 ppm), the 4-fluorophenyl protons (7.2-7.3 ppm), the ethyl group (1.2 ppm), and the dimethylamino group (2.8-3.2 ppm). Integration values are provided for each major peak group.

Chemical Shift (ppm)	Integration
10.157	1.00
9.181	1.00
8.545	1.00
8.527	1.00
8.510	1.00
8.079	1.00
8.061	1.00
7.815	1.00
7.744	1.00
7.715	1.00
7.496	2.00
7.476	2.00
7.385	2.00
7.367	2.00
7.349	2.00
7.314	2.00
7.291	2.00
7.280	2.00
7.117	2.01
7.095	2.01
7.075	2.01
5.984	2.01
5.062	2.00
5.046	2.00
5.031	2.00
3.840	2.00
3.825	2.00
3.810	2.00
3.795	2.00
3.244	4.00
3.225	4.00
3.211	4.00
3.198	4.00
3.184	4.00
2.5	6.00
1.262	6.00
1.244	6.00
1.226	6.00



2-(2-(dimethylamino)ethyl)-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-*b*]indol-2-ium chloride (**3u**)



2-(4-(diethylamino)butyl)-11-(3-phenylpropyl)-2,11-dihydroimidazo[1',5':1,2]pyrido[3,4-b]indol-2-ium chloride (**3v**)

