

## **Supporting information (New Journal of Chemistry)**

### **Fluorescent probe for Lewisite Simulant**

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## General

### Materials

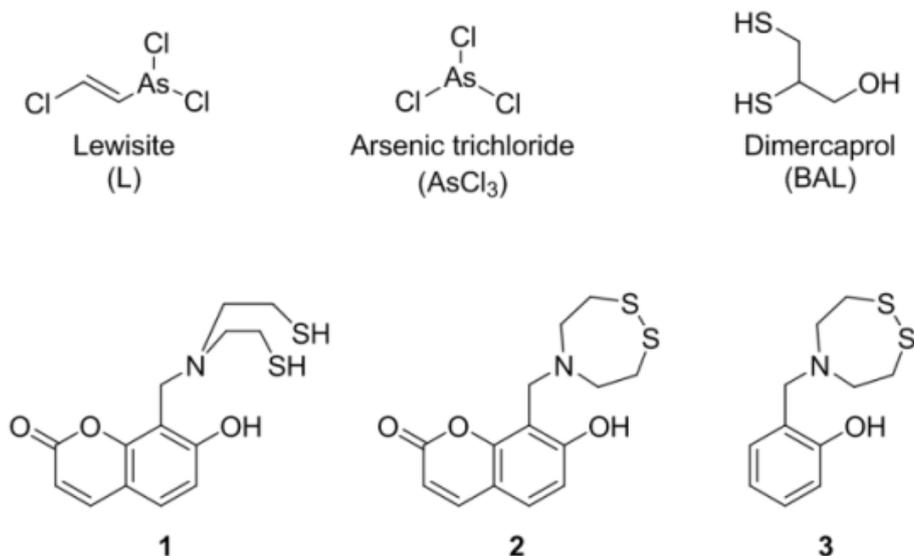
7-hydroxycoumarin, acetic anhydride, 1,3,5,7-tetraazaadamantane, triphenylmethanethiol, bis(2-chloroethyl)amine, sodium cyanoborohydride, trifluoroacetic acid (TFA), triisopropylsilane (TIPS), dichloromethane (DCM), methanol (MeOH), cyclohexane, hexane, ethyl acetate, tetrahydrofuran (THF) and  $\text{CDCl}_3$  were purchased as reagent grade from Aldrich, Acros, Samchun, TCI and used as received. The used metal salts are  $\text{Hg}(\text{OAc})_2$ ,  $\text{Zn}(\text{ClO}_4)_2$ ,  $\text{AgNO}_3$ ,  $\text{Cd}(\text{ClO}_4)_2$ ,  $\text{Cu}(\text{ClO}_4)_2$ ,  $\text{Fe}(\text{ClO}_4)_2$ ,  $\text{Pb}(\text{ClO}_4)_2$ .

### Instruments

**NMR characterization:**  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectra were recorded by Advance 300 and 75 MHz Bruker spectrometer in chloroform- $d_3$ . Chemical shifts were expressed in parts per million ( $\delta$ ) and reported as s (singlet), d (doublet), t (triplet) and m (multiplet).

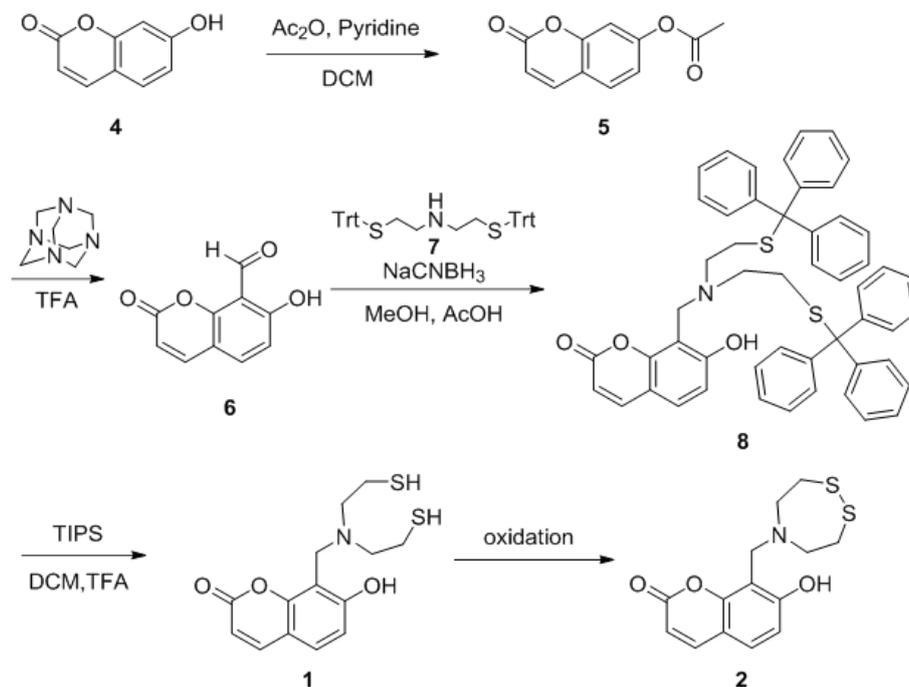
**Fluorescence & UV-Vis experiment:** Probe **2** was dissolved in THF to afford a concentration of 10 mM stock solution, which was diluted to 10  $\mu\text{M}$  with distilled water up. Analyte was added into 10  $\mu\text{M}$  of **2** in the presence of TCEP (12  $\mu\text{M}$ ), and photophysical property of **2** was measured in real time. Fluorescence and UV-Vis absorbance were recorded on Jasco FP-6500 and Beckman DU 800 spectrophotometer, respectively.

## Chemical structures



**Chart S1.** Chemical structures of probes, BAL, lewisite, and lewisite simulant

## Synthesis of probe

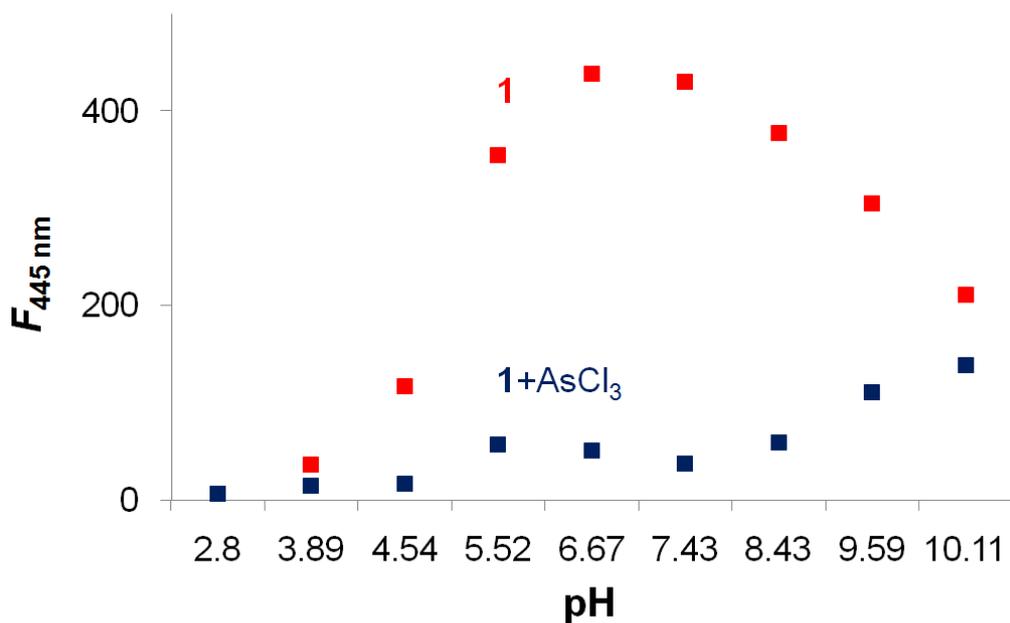


**Scheme S1.** Synthetic procedure of probes

**8-((bis(2-(tritylthio)ethyl)amino)methyl)-7-hydroxy-2H-chromen-2-one (8):** To a solution of compound **6**<sup>1</sup> (1.99 g, 10 mmol) in methanol/DCM (100 mL/50 mL) was added compound **7**<sup>2</sup> (6.22 g, 10 mmol), and then a small amount of acetic acid was further added. Sodium cyanoborohydride (0.63 g, 10 mmol) was added dropwise to the ice-cooled resulting solution under stirring. After the solution was stirred for three days at room temperature, it was acidified by adding conc. HCl and then evaporated almost to dryness under reduced pressure. The residue was dissolved in saturated Na<sub>2</sub>CO<sub>3</sub> and extracted with DCM. The fractions were combined, dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>, and evaporated under reduced pressure to give amber-colored oil. The residue was further purified on a silica-gel column with hexane and ethyl acetate to provide compound **8** in 42% yield. <sup>1</sup>H NMR (CDCl<sub>3</sub>, 300 MHz) δ = 2.13 (t, 4H), 2.26 (t, 4H), 3.61 (s, 2H), 6.17 (d, 1H), 6.70 (d, 1H), 7.20 (m, 31H), 7.62 (d, 1H).

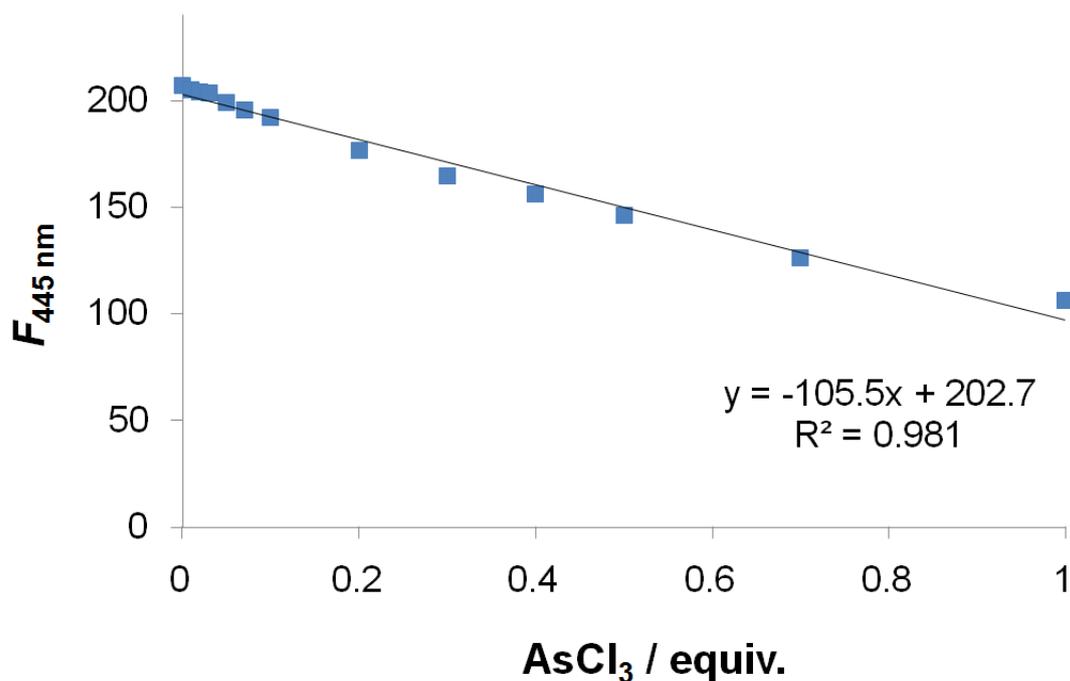
**8-((1,2,5-dithiazepan-5-yl)methyl)-7-hydroxy-2H-chromen-2-one (2):** Compound **8** (3.34 g, 4.2 mmol) was deprotected by treatment with DCM:TFA:TIPS (50:47.5:2.5, v/v/v, 400 mL) during 1 h. Deprotection solution was evaporated under reduced pressure and residual TFA was removed by co-evaporation with cyclohexane (3 × 100 mL) and dried *in vacuo*. The residue was dissolved in DCM and dried over anhydrous Na<sub>2</sub>SO<sub>4</sub> and evaporated under reduced pressure to give amber-colored oil. The residue was air-oxidized in methanol/water with Na<sub>2</sub>CO<sub>3</sub> prior to the purification. The resulting residue was further purified on a silica-gel column with hexane and DCM to give a white solid in 33% yield. <sup>1</sup>H NMR (CDCl<sub>3</sub>, 300 MHz) δ = 2.95 (t, 4H), 3.30 (t, 4H), 4.35 (s, 2H), 6.20 (d, 1H), 6.81 (d, 1H), 7.31 (d, 1H), 7.62 (d, 1H). <sup>13</sup>C NMR (CDCl<sub>3</sub>, 75 MHz) δ = 162.7, 161.0, 153.0, 144.3, 128.4, 113.9, 111.7, 111.5, 108.3, 56.6, 53.3, 38.0. HRMS: calculated for C<sub>14</sub>H<sub>16</sub>O<sub>3</sub>NS<sub>2</sub> [M+H]<sup>+</sup> 310.0572; found 310.0581.

## pH profiles of 1



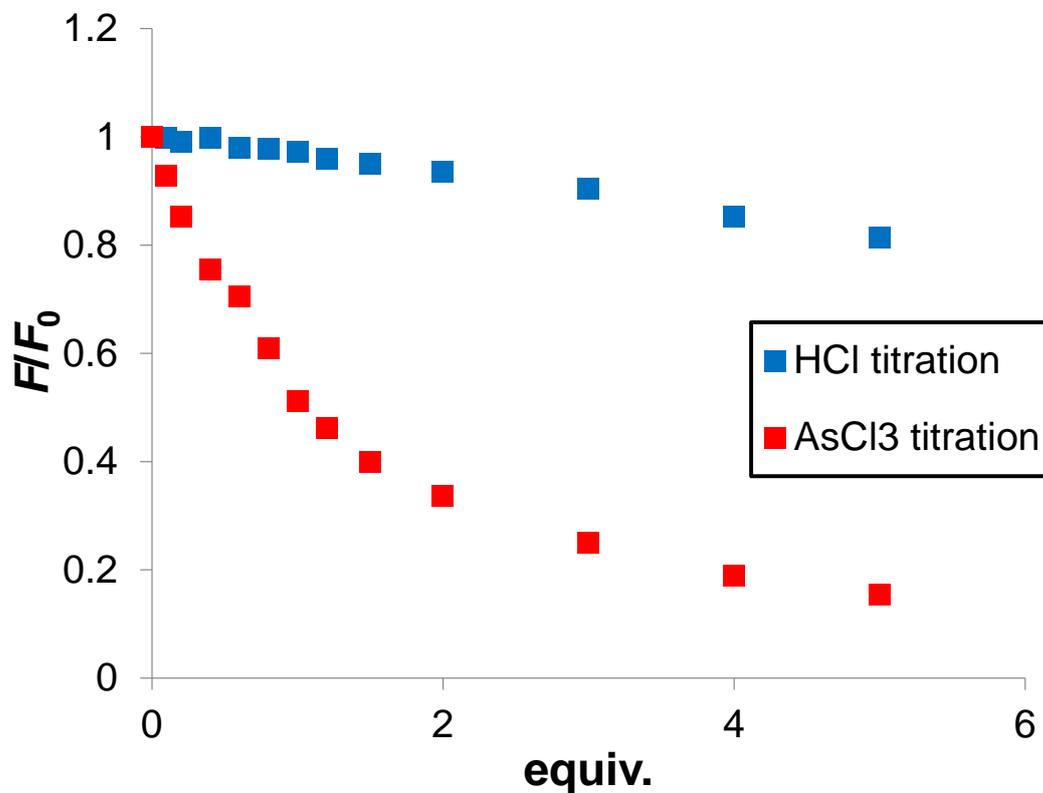
**Fig. S1** Changes in the fluorescence intensity (at 445 nm) of 1 (10  $\mu\text{M}$ ) (red square) upon addition of 10 equiv. of  $\text{AsCl}_3$  (blue square) in the presence of TCEP (12  $\mu\text{M}$ ) in water (pH 2.8–10.11). The fluorescence intensity was obtained by excitation at 370 nm.

## Limit of detection



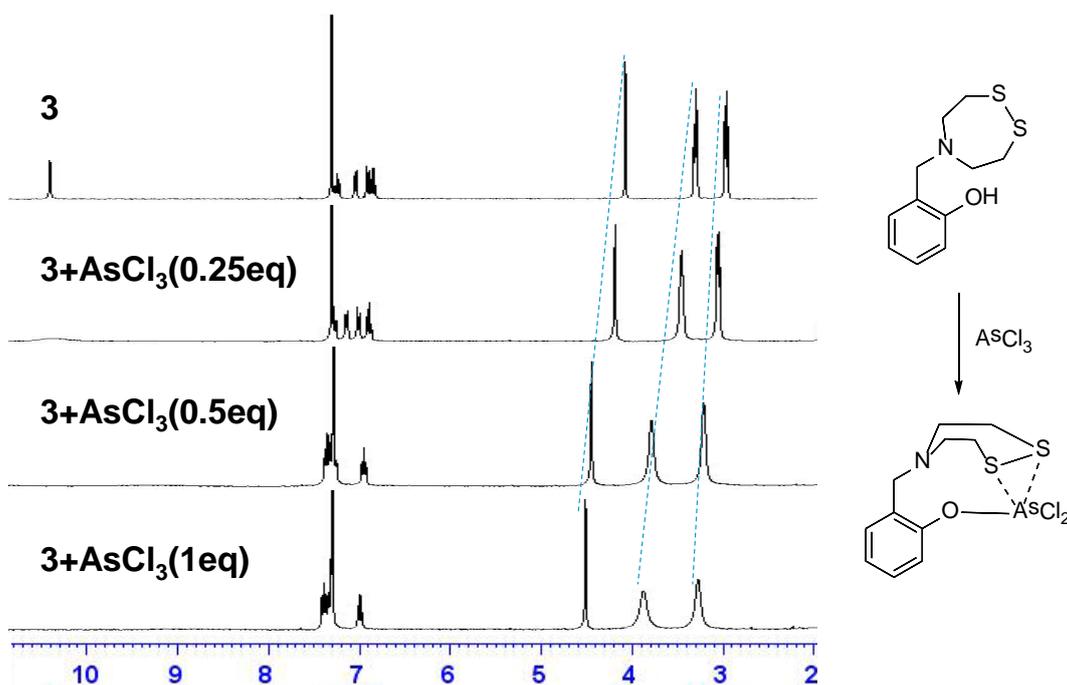
**Fig. S2** Linear range of fluorescence quenching of 1 (10  $\mu\text{M}$ ) upon addition of  $\text{AsCl}_3$  (0–1.0 equiv.) in the presence of TCEP (12  $\mu\text{M}$ ) in water. The fluorescence intensity was obtained by excitation at 370 nm.

## Comparison of HCl titration with AsCl<sub>3</sub> titration



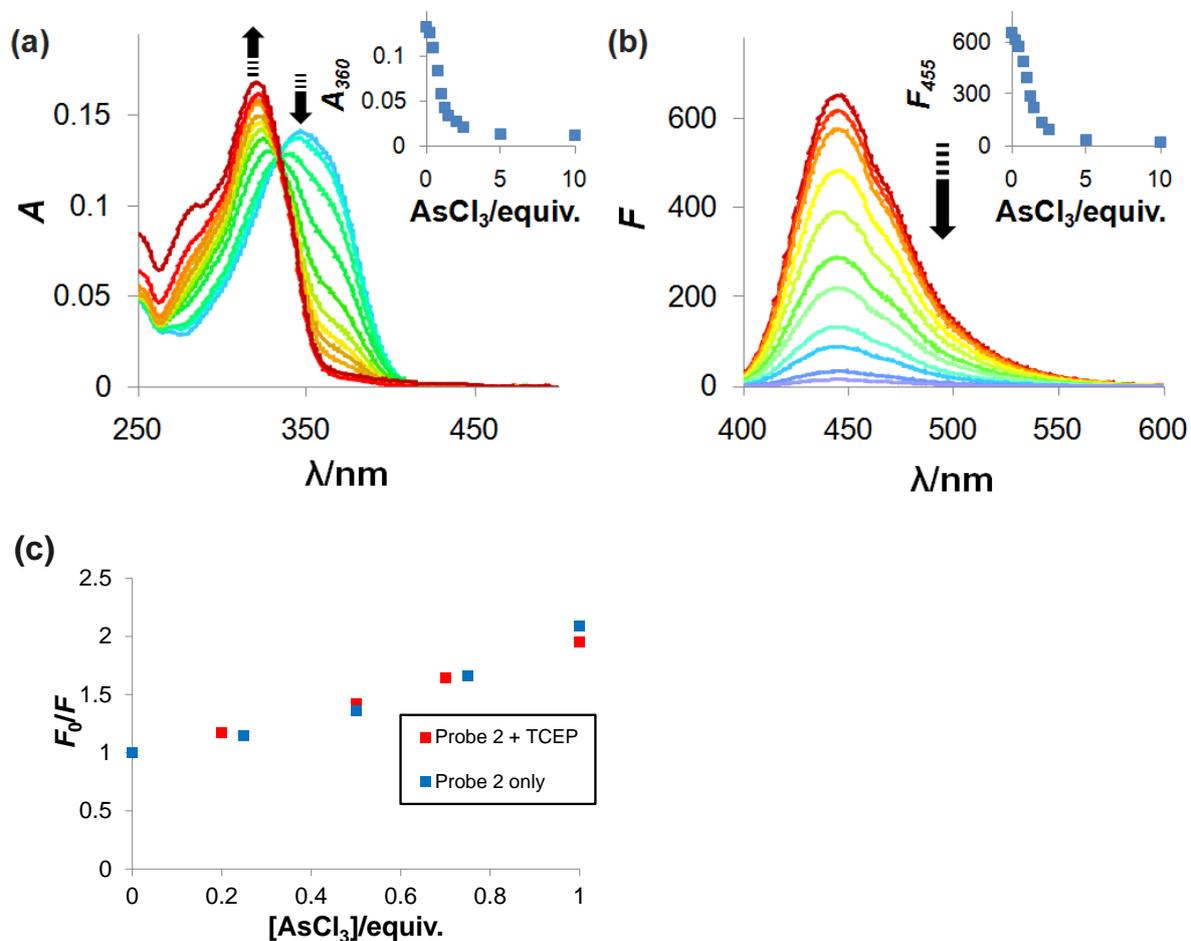
**Fig. S3** Changes in the fluorescence intensity ratio ( $F/F_0$ ) of **2** upon addition of increasing amount of HCl (blue square) and AsCl<sub>3</sub> (red square):  $F$  = the intensity of **2** ( $\lambda_{em} = 445$  nm) upon addition of HCl or AsCl<sub>3</sub>,  $F_0$  = the initial intensity.

## <sup>1</sup>H NMR titration



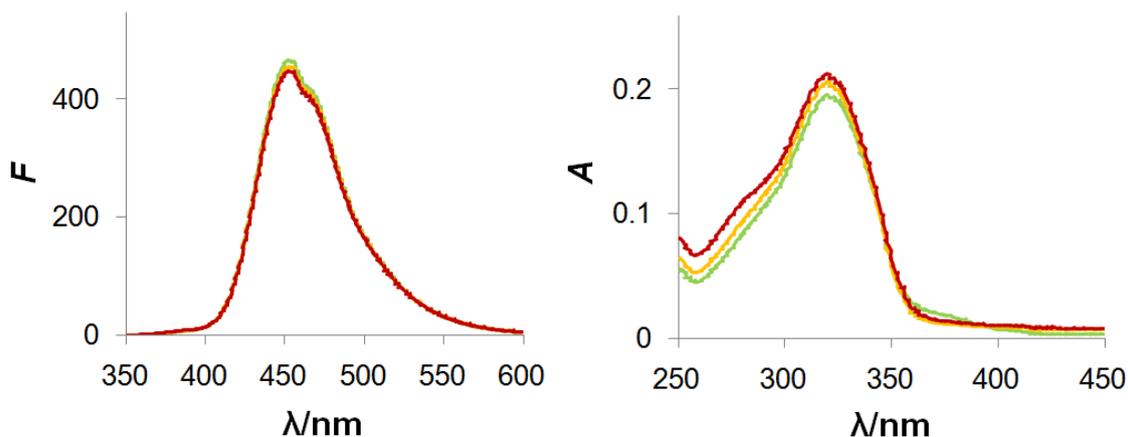
**Fig. S4** <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) spectra of **3** upon the addition of AsCl<sub>3</sub> (0–1.0 equiv.).

## Photo-physical property of 2



**Fig. S5** UV-Vis absorbance (a) and fluorescence spectra (b) of **2** (10  $\mu\text{M}$ ) upon addition of  $\text{AsCl}_3$  (0–10 equiv.) in water. The inset of panels shows absorbance ( $\lambda_{\text{abs}} = 360$  nm) (a) and emission ( $\lambda_{\text{em}} = 445$  nm) (b) intensity of **2** (10  $\mu\text{M}$ ) upon  $\text{AsCl}_3$  addition (0–10 equiv.). The fluorescent emission was monitored by excitation at 370 nm. (c) Fluorescence intensities at 455 nm ( $F_0/F$ ) upon titration of probe **2** (blue square) and probe **2** + TCEP (red square) with  $\text{AsCl}_3$  (0–1 equiv.).

## Photo-physical property of 4



**Fig. S6** Fluorescence (a) and UV-Vis absorption spectra (b) of **4** (10  $\mu\text{M}$ ) upon addition of  $\text{AsCl}_3$  (0–10 equiv.) in water. The fluorescent emission was monitored by excitation at 340 nm.

## $\text{AsCl}_3$ quantification in soil

**Experimental method:** 2.0 g of soil was sprayed with  $\text{AsCl}_3$  (0–5  $\mu\text{L}$ ) in THF and allowed to stand for 2 h. Then, the soil sample was centrifuged with water (10 mL), and quantification was conducted with probe **2** (10  $\mu\text{M}$ ).<sup>3</sup>

## $\text{LC}_{50}$ and $\text{LD}_{50}$ of blister agents

**Table S1.** Lethal concentration and time ( $\text{LC}_{50}$ ) and lethal dose ( $\text{LD}_{50}$ ) of lewisite, sulfur/nitrogen mustard<sup>4</sup>

Blister agent	$\text{LC}_{50}$ Inhalation $\text{mg}\cdot\text{min}/\text{m}^3$	$\text{LD}_{50}$ Skin $\text{mg}/\text{kg}$
Lewisite (L)	1400	30
Sulfur mustard (HD)	1500	100
Nitrogen mustard (HN-1)	1500	No data available

# Selected $^1\text{H}$ , $^{13}\text{C}$ NMR and mass spectra

\*MSD1 SPC, time=10.012 of D:\JHONGLDH\TCEP.D ES-API, Pos, Scan, Frag: Var

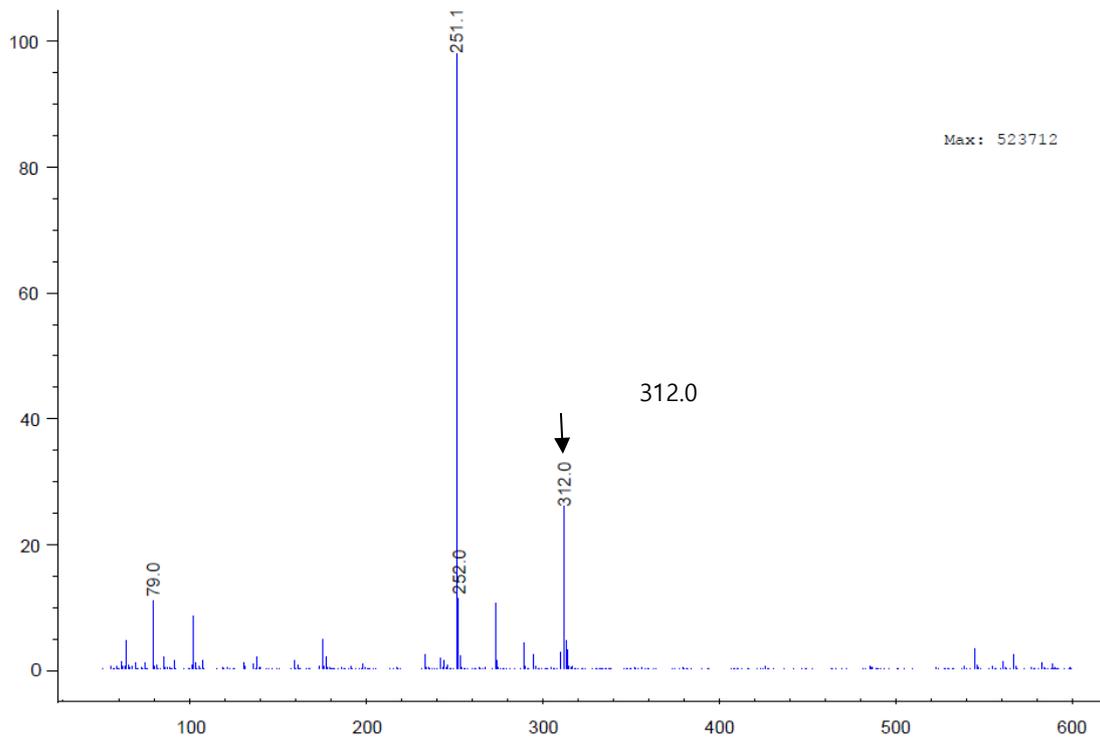


Fig. S7 Mass spectrum of 1 (2+TCEP)

\*MSD1 SPC, time=3.129 of D:\JHONGLDH\ICMR TCEP ASCL3(20EQ).D ES-API, Pos, Scan, Frag: Var

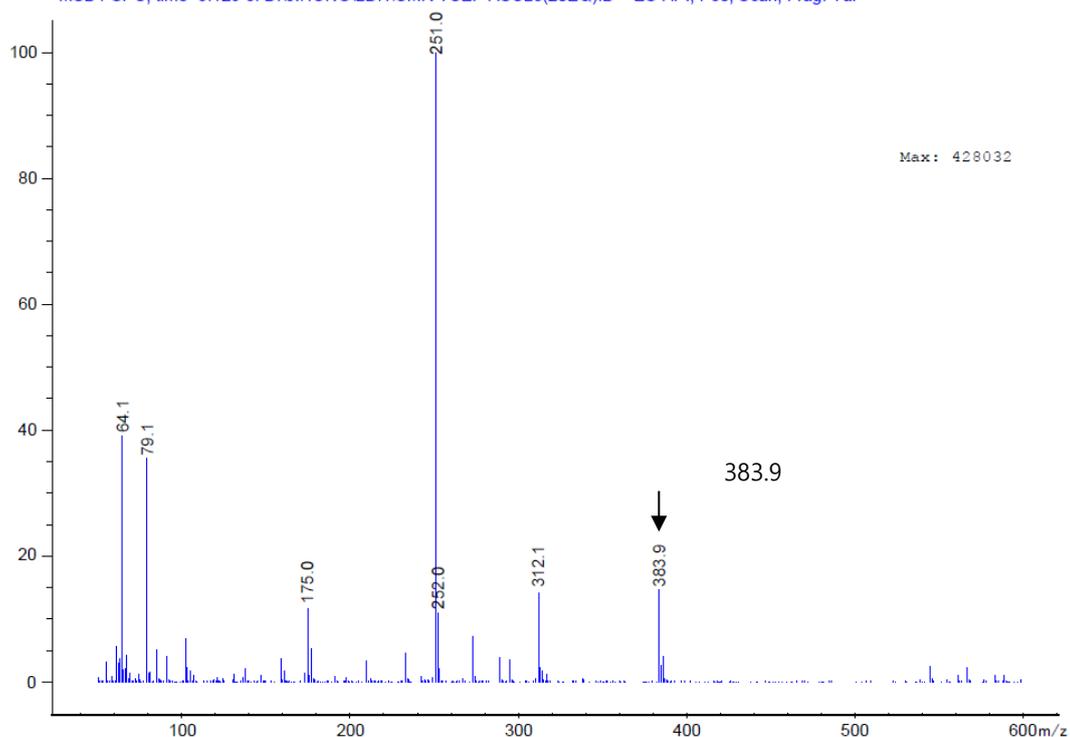
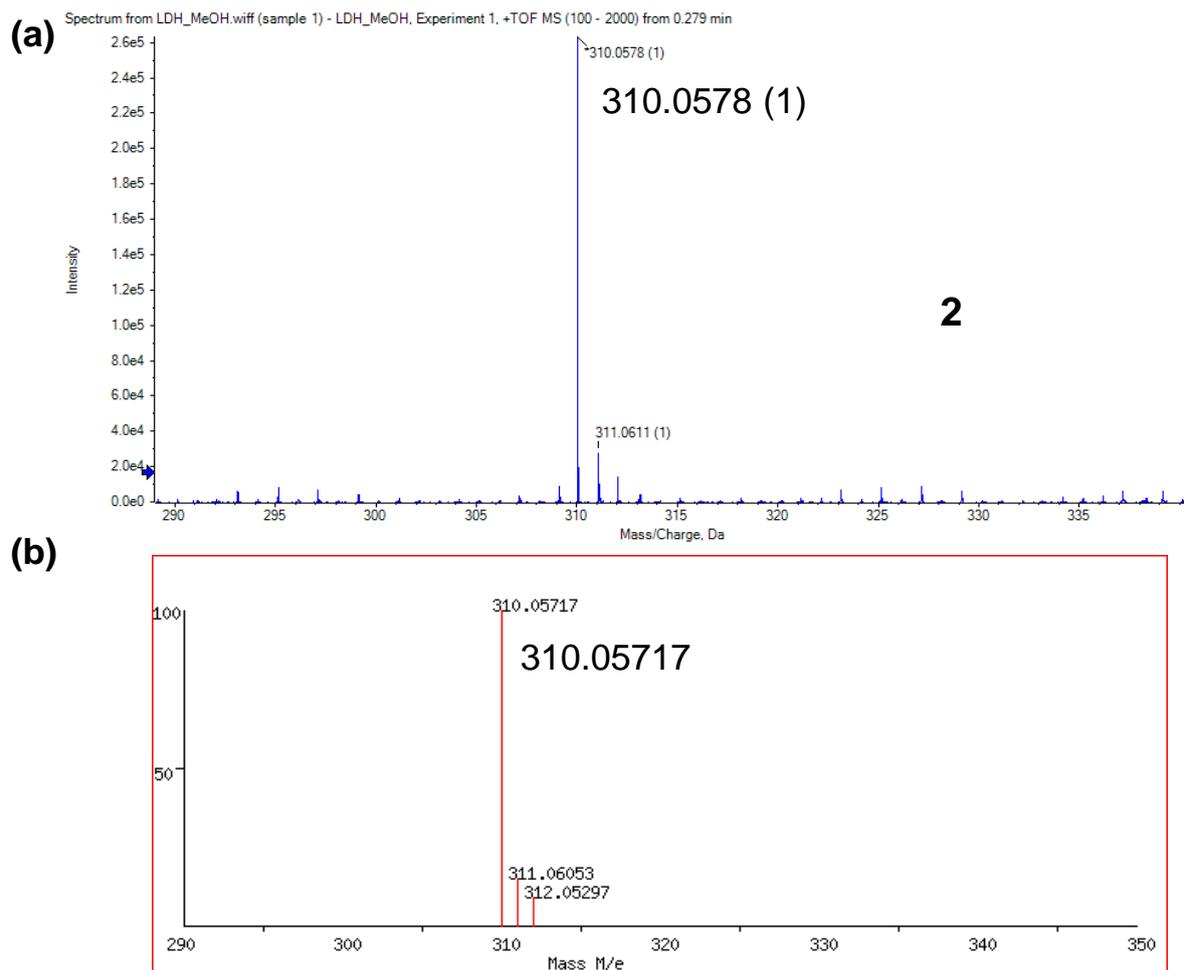


Fig. S8 Mass spectrum of 1 upon presence of  $\text{AsCl}_3$  (2+TCEP+ $\text{AsCl}_3$ )



**Fig. S9** (a) Experimental HRMS (TOF, MeOH) spectrum and (b) theoretical isotope distribution of compound **2** (calculated mass: 310.0572, measured mass: 310.0578, Formula:  $[M+H]^+$ ,  $C_{14}H_{16}O_3NS_2^+$ ). The theoretical isotope distribution was determined from the software, Isotope Distribution Calculator and Mass Spec Plotter.

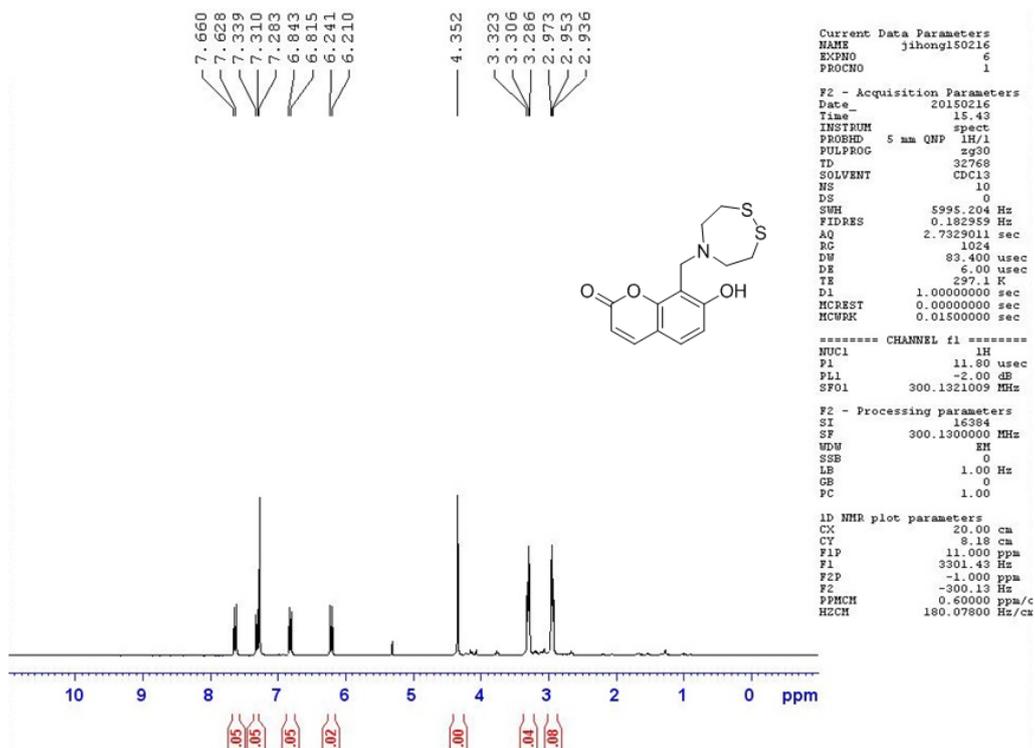


Fig. S10 <sup>1</sup>H NMR Spectrum of 2

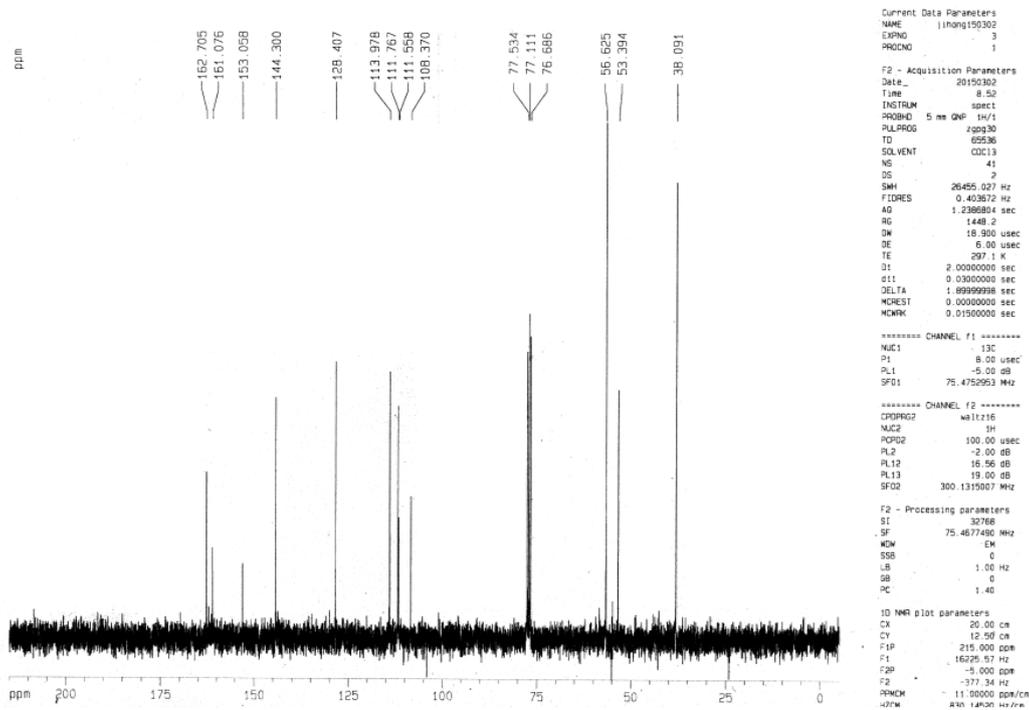


Fig. S11 <sup>13</sup>C NMR Spectrum of 2

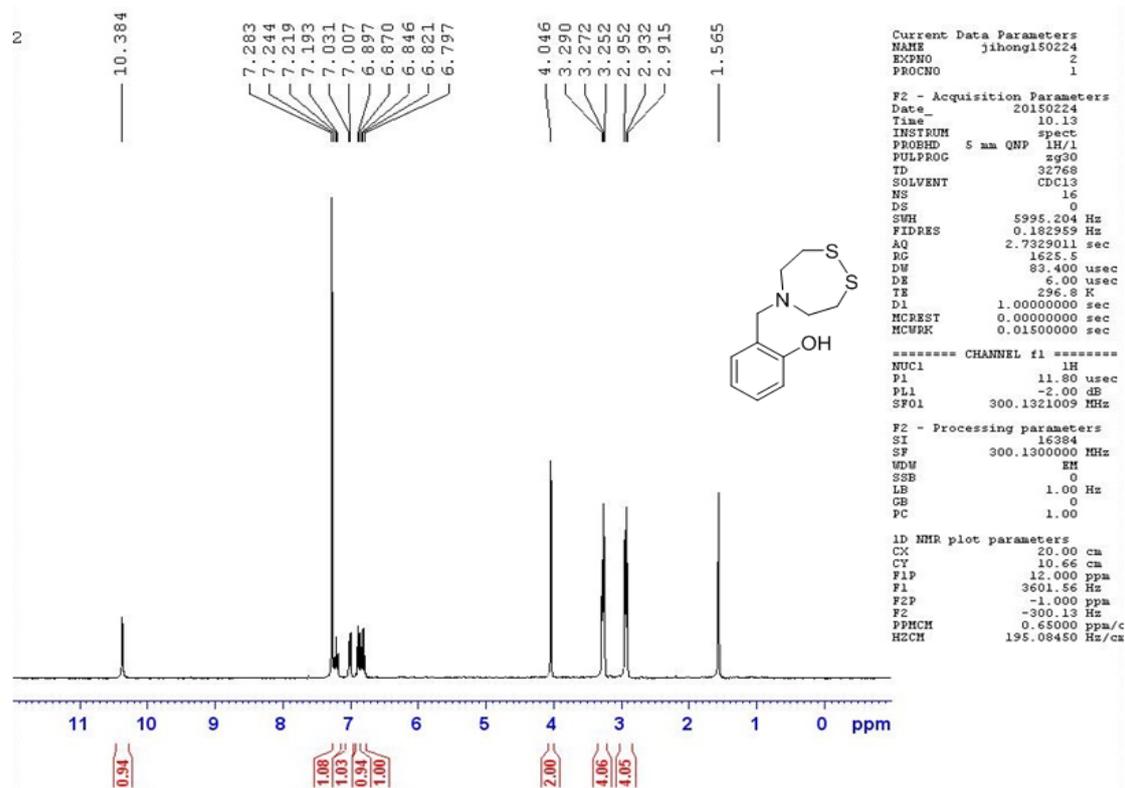


Fig. S12  $^1\text{H}$  NMR Spectrum of **3**

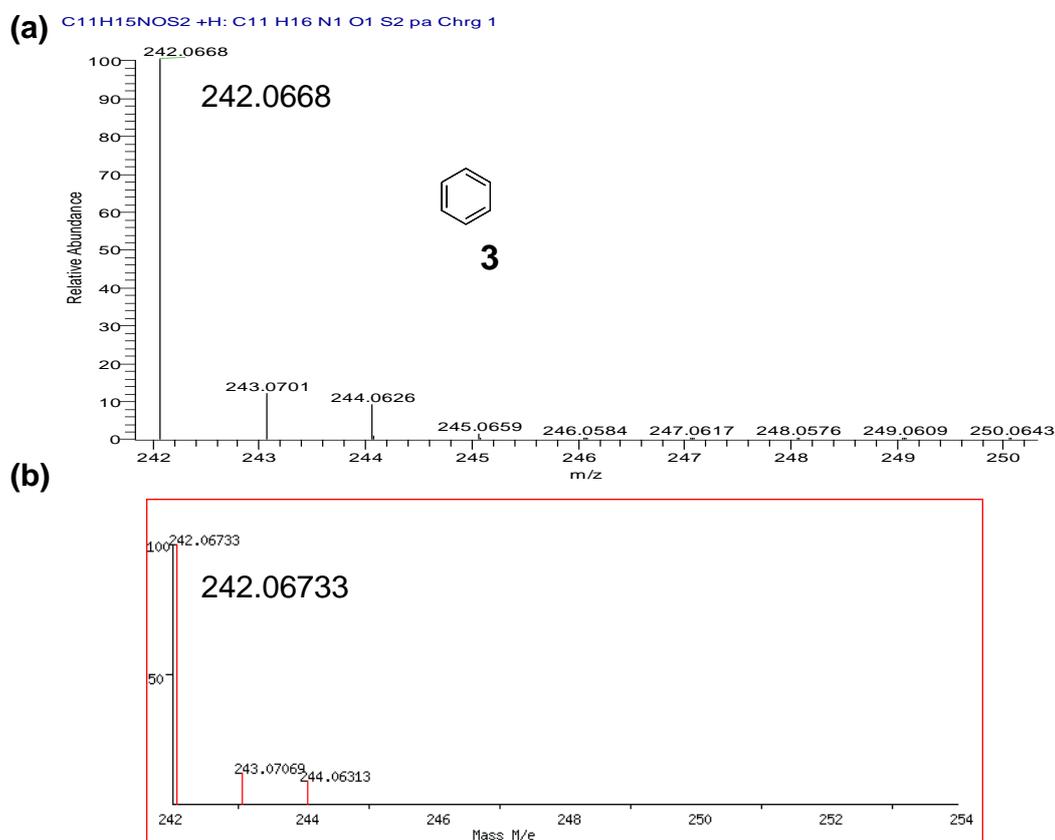


Fig. S13 (a) Experimental HRMS (ESI, MeOH) spectrum and (b) theoretical isotope distribution of compound **3** (calculated mass: 242.0673, measured mass: 242.0668, Formula:  $[\text{M}+\text{H}]^+$ ,  $\text{C}_{11}\text{H}_{16}\text{ONS}_2^+$ ).

## Reference

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