Bromophycoic acids: Bioactive natural products from a Fijian red alga *Callophycus* sp.

Margaret E. Teasdale[†], Tonya L. Shearer[†], Sebastian Engel[†], Troy S. Alexander[#‡], Craig R. Fairchild[§], Karine Le Roch[⊥], Jacques Prudhomme[⊥], William Aalbersberg[//], Mark E. Hay[†], Julia Kubanek*[†‡]

Supporting Information

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Table 1. Red alga of the class Florideophyceae for phylogenetic analysis and corresponding GenBank accession numbers for the small subunit ribosomal RNA (18S rRNA) and cytochrome *c*.

			GenBank Accessions	
Subclass	Order	Species	18S rRNA	COI
Rhodymeniophycidae	Ceramiales	*Laurencia majuscula*	GU223784	HQ422617
		Leveillea jungermannioides	GU223793	HQ423107
		Polysiphonia fucoides	AF427530	HM573496
	Gelidiales	*Gelidium pusillum*	U32564	HQ412446
		Pterocladiella caerulescens	EF191193	HQ412475
	Gigartinales	*Callophycus densus*	FJ660609	
		Callophycus serratus	FJ660613	JX135006
		Callophycus oppositifolius	AY437654	
		Dumontia contorta		AY971161
		Gibsmithia dotyi	AF317108	HQ422673
		Hennedya crispa	AY437652	
		Hypnea flexicaulis	EU240850	FN823052
		Portieria hornemanii	AF317118	HQ422692
	Gracilariales	*Gracilaria vermiculophylla*	GQ292853	EF434926
	Rhodymeniales	*Champia parvula*	EF190546	HQ422763
		Coelothrix irregularis	EU086456	HQ422592
		Rhodymenia leptophylla	U09621	HM033088
Corallinophycidae	Corallinales	*Corallina elongata*	EU095607	FM180065
		Haliptilon squamatum	EU095617	FM180090
		Jania rubens	EU095621	FM180064
Hildenbrandiophycidae	Hildenbrandiales	*Hildenbrandia rubra*	AF076995	HQ422942

Table 2. Results of similarity searches of G-0807 small subunit ribosomal RNA (18S rRNA) and cytochrome *c* oxidase subunit 1 (COI) from BLAST search in the GenBank nucleotide database.

	Similar species	GenBank accession	E-value	Max identity
18S rRNA	*Callophycus oppositifolius*	AY437654	0	99%
	Hennedya crispa	AY437652	0	99%
	Mychodeophyllum papillitectum	AY437687	0	98%
	Areschougia congesta	U09613	0	98%
	Calviclonium ovatum	AY437650	0	98%
	Acrotylus australis	AY437647	0	98%
	Tichocarpus crinitus	AY437698	0	98%
	Schmitziella endophloea	AY437697	0	98%
	Erythroclonium angustatum	AY437655	0	98%
	Mychodea marginifera	AY437685	0	98%
	Rhabdonia verticillata	AY437656	0	98%
	Mychodea pusilla	AY437686	0	98%
	Mychodea acanthymenia	EF033589	0	98%
	Austroclonium charoides	AY437666	0	98%
	Furcellaria lumbricalis	Z14141	0	98%
	Mychodea carnosa	U33135	0	98%
	Nizymenia australis	U09616	0	98%
	Dicranema revolutum	AY437678	0	98%
	Phacelocarpus peperocarpos	U09617	0	97%
	Caulacanthus okamurae	AY437663	0	97%
COI	*Dumontia contorta*	AY971161	5e-164	88%
	Predaea sp.	HQ422703	5e-164	88%
	Kallymeniaceae sp.	JQ255028	2e-162	88%
	Euthora timburtonii	GU140181	2e-162	88%
	Acrosymphyton taylorii	HQ422907	1e-160	88%
	Pugetia cryptica	JF903305	2e-152	87%

Table 3. COSY correlations for bromophycoic acids A-E (**1-5**). For diastereotopic protons with dissimilar chemical shifts, the proton whose chemical shift is listed first in Table 1 of the main article is termed "a" and the other is "b". "NA" (not applicable) indicates that no proton signal exists for that position.

[1]H at Position #	COSY correlations observed between protons listed on far left and those below:				
	1	**2**	**3**	**4**	**5**
3	-	5a, 5b	5a, 5b		5a, 5b
5a	5b, 6	3, 5b, 6	3, 5b, 6	5b, 6	3, 5b, 6
5b	5a, 6	3, 5a, 6	3, 5a, 6	5a, 6	3, 5a, 6
6	5a, 5b	5a, 5b	5a, 5b	5a, 5b	5a, 5b, 21a, 21b
8a	8b	8b	8b, 22b	8b	NA
8b	8a	8a, 22b	8a, 22b	8a	NA
9a	NA	NA	NA	NA	9b, 10a, 10b
9b	NA	NA	NA	NA	9a, 10a, 10b
10a	11a, 11b	10b, 11a, 11b	10b, 11a, 11b,	-	9a, 9b, 10a, 11
10b	NA	10a, 11a, 11b	10a, 11a, 11b	-	9a, 9b, 10a, 11
11a	10, 11b, 12	10a, 10b, 11b, 12	10a, 10b, 11b, 12	11b, 12	10a, 10b
11b	10, 11a, 12	10a, 10b, 11a, 12	10a, 10b, 11a, 12	11a, 12	NA
12	11a, 11b	11a, 11b	11a, 11b	11a, 11b	NA
13a	NA	NA	NA	NA	13b, 14a, 14b
13b	NA	NA	NA	NA	13a, 14a, 14b
14a	15a, 15b	15, 16	15, 16	15a, 15b	13a, 13b, 14b, 15
14b	-	-	-	-	13a, 13b, 14a, 15
15a	14, 15b, 16	14, 16	14, 16	14, 15b	14a, 14b, 17, 27
15b	14, 15a, 16	NA	NA	14, 15a	NA
16	15a, 15b	14, 15a	14, 15	-	NA
17	NA	NA	NA	NA	15
18a	-	-	-	27	19
18b	NA	NA	NA	27	NA
19	20	20	20	20	18
20	19	19	19	19	NA
21a	NA	NA	NA	NA	6, 21b, 22
21b	NA	NA	NA	NA	6, 21a
22a	22b	22b	22b	22b, 23a, 23b	21a
22b	22a, 23	8b, 22a, 23a, 23b	8a, 8b, 22a, 23b	22a, 23a, 23b	-
23a	22b	22b, 23b, 24	23b	22a, 22b	-
23b	NA	22b, 23a	22b, 23a	22b	NA
24	-	-	-	-	-
25	-	-	-	-	-
26	-	-	-	-	-
27	-	-	-	18a, 18b	15

Table 4. HMBC correlations for bromophycoic acids A-E (**1-5**). For diastereotopic protons with dissimilar chemical shifts, the proton whose chemical shift is listed first in Table 1 of the main article is termed "a" and the other is "b". "NA" (not applicable) indicates that no proton signal exists for that position.

^{1}H at Position #	HMBC Correlations observed between protons listed on far left and carbons at positions listed below:				
	1	**2**	**3**	**4**	**5**
3	1, 5, 19, 21	1, 5, 19, 21	1, 5, 19, 21	1, 5, 19, 21	1, 5, 18, 20
5a	3, 4, 7, 21	4, 7, 21	4, 7, 21	4, 7	4, 6, 20, 21
5b	3, 4, 6, 7, 21	4, 6, 7, 21	4, 6, 7, 21	3, 4, 6, 7	3, 4, 6, 7, 20
6	5, 7, 21	5, 7	5, 7	7	5, 7, 24
8a	-	6, 7, 9, 10	6, 7, 25	6, 7 ,9 ,25	N/A
8b	6, 7, 9, 22, 24, 25	6, 7, 9, 22, 24	7, 9, 22, 24, 25	7	N/A
9a	NA	NA	NA	NA	8, 11
9b	NA	NA	NA	NA	8, 11, 25
10a	-	-	-	-	12
10b	-	12	12, 25	-	11, 12
11a	9, 10, 12	9	9	-	9, 10, 12, 13, 26
11b	10, 12	-	-	-	N/A
12	11, 13, 26	11, 13, 26	11, 26	26	N/A
13a	NA	NA	NA	NA	11, 12
13b	NA	NA	NA	NA	11, 12, 14
14	9, 12, 13, 16, 23, 24	12, 13, 15, 16, 24, 26	12, 13, 15, 16, 24, 26	-	-
14b	-	-	-	-	15
15a	16, 17	14, 16, 17	14, 16, 17	16	17, 27
15b	16, 17	NA	NA	16	N/A
16	14, 15, 18, 27	14,15, 17, 18, 27	14, 15, 17, 18, 27	NA	N/A
17	NA	NA	NA	NA	15, 16, 27
18a	14, 16, 17, 27	16, 17, 27	16, 17, 27	16, 27	1, 3, 20
18b	NA	-	-	16, 17, 27	NA
19	1, 3, 21	1, 3, 21	1, 3, 21	1, 3, 21	1, 2, 4, 20
20	2, 3, 4, 21	2, 4, 21	2, 4, 21	2, 4	NA
21a	NA	NA	NA	NA	-
21b	NA	NA	NA	NA	6
22a	-	-	24	-	-
22b	7, 8, 23, 24	-	-	-	-
23a	-	-	-	-	12, 13
23b	-	-	-	22, 24	NA
24	-	-	9, 10, 13, 26	13, 9, 22, 26	6, 7, 8
25	8, 9, 10, 24	8, 9, 10, 24	6, 8, 9, 10, 24	8, 9, 10, 24	7, 8, 9, 23
26	12, 13, 14, 24	12, 13, 14, 24	12, 13, 14, 15, 24	12, 13, 14, 24	1, 12, 13, 23
27	14, 16, 17, 18	16, 17, 18	16, 17, 18	16, 17, 18	15, 16, 17

Table 5. Observed NOEs from NOESY and ROESY NMR experiments, for bromophycoic acids A-E (**1-5**). For diastereotopic protons with dissimilar chemical shifts, the proton whose chemical shift is listed first in Tables 1 of the main article is termed "a" and the other is "b". Only NOEs important to determinations of stereochemistry are listed.

^{1}H at Position #	NOE observed between protons listed on far left and protons at positions listed below:				
	1	**2**	**3**	**4**	**5**
3	5b	5a, 5b, 6		5a, 5b	5a, 5b
5a	6, 8b, 25	3, 6, 8b, 25	6	3, 6, 25	3, 24
5b	3, 6, 8b, 22b, 25	3, 8b	8b	3, 6, 8b	3, 6, 21b
6	5a, 5b, 22b, 23, 25	3, 5a, 22b, 23a, 25	5a, 22b, 23a, 25	5a, 5b, 22b, 23a, 25	5b, 21b, 25
8a					
8b	5a, 5b, 25	5a, 5b	5b	5b	
9a					24
9b					
10a	12, 24		12		9b, 11
10b		11a, 11b			25, 26
11a	12, 14	10b, 12, 24	12	12	10a, 23, 24
11b	25, 26	10b, 25, 26	25	25, 26	
12	10a, 11a, 14, 24	11a, 24	10a, 11a, 24	11a	
13a					
13b					
14a	11a, 12				
14b					
15a					
15b					
16					
17					
18a					
18b					
19					
20					
21a					
21b					5b, 6
22a					
22b	5b, 6, 23	6	6	6, 23a	
23a	6, 22b, 25, 26	6, 25, 26	6	6, 22b	11, 24
23b					
24	10a, 12	11a, 12	12		5a, 9a, 11, 23
25	5a, 5b, 6, 8b, 11b, 23, 26	5a, 6, 11b, 23a, 26	6, 11b, 26	5a, 6, 11b	6, 10b
26	11b, 23, 25	11b, 23a, 25	25	11b	10b
27					

Table 6. HSQC-TOCSY correlations for bromophycoic acid E (**5**). For diastereotopic protons with dissimilar chemical shifts, the proton whose chemical shift is listed first in Table 1 of the main article is termed "a" and the other is "b".

^{1}H at Position #	HSQC-TOCSY observed between protons listed on far left and carbons at positions listed below:
3	3, 5, 7, 19
5a	5, 6
5b	5, 6
6	5, 6
8a	
8b	
9a	9, 10, 11
9b	9, 10, 11
10a	9, 10, 11
10b	9, 10, 11
11a	9, 10, 11
11b	
12	
13a	13, 14
13b	13, 14
14	13, 14, 15
14b	13, 14, 15
15a	13, 14, 15, 17
15b	
16	
17	
18a	18, 19
18b	
19	18, 19
20	
21a	6, 22, 23
21b	6, 22, 23
22a	21, 22, 23
22b	
23a	21, 22, 23
23b	
24	
25	
26	
27	

Figure 1. ^{1}H NMR spectrum of bromophycoic acid A (**1**) (500 MHz; DMSO-d_6).

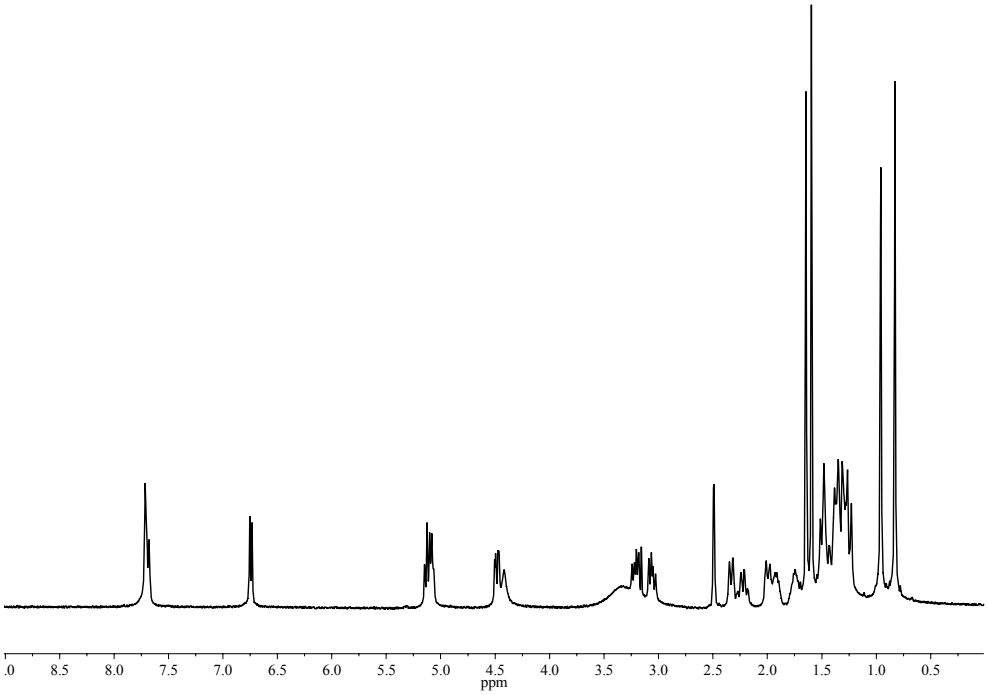

Figure 2. ^{13}C NMR spectrum of bromophycoic acid A (**1**) (125 MHz; DMSO-d_6).

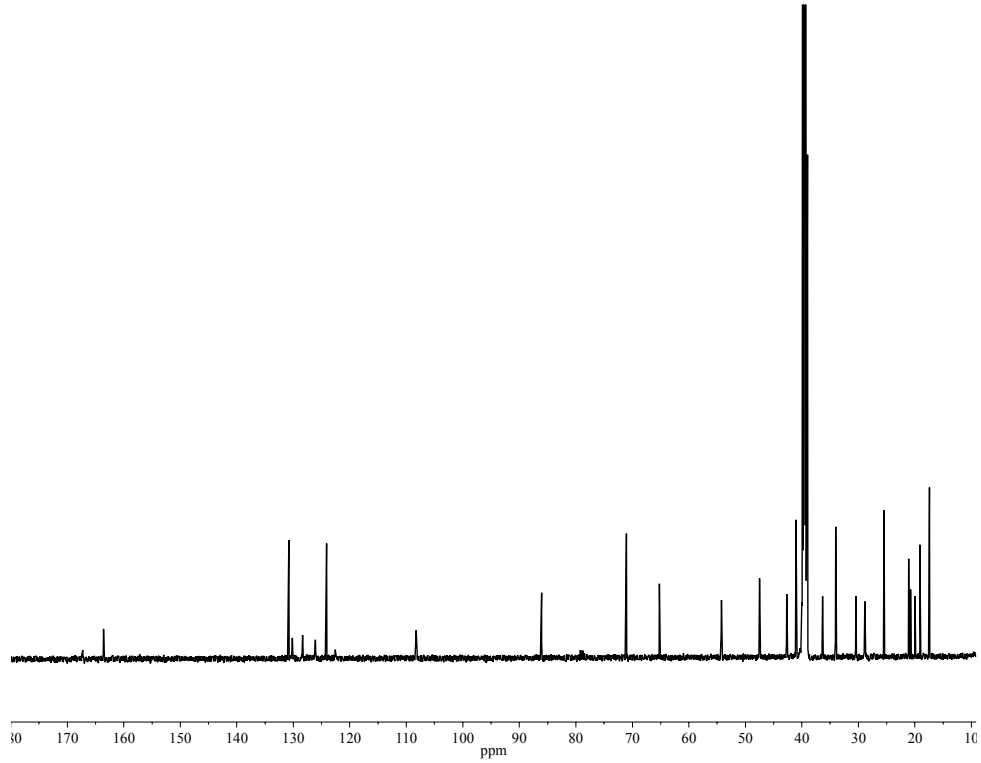

Figure 3. HSQC NMR spectrum of bromophycoic acid A (**1**) (DMSO-d_6).

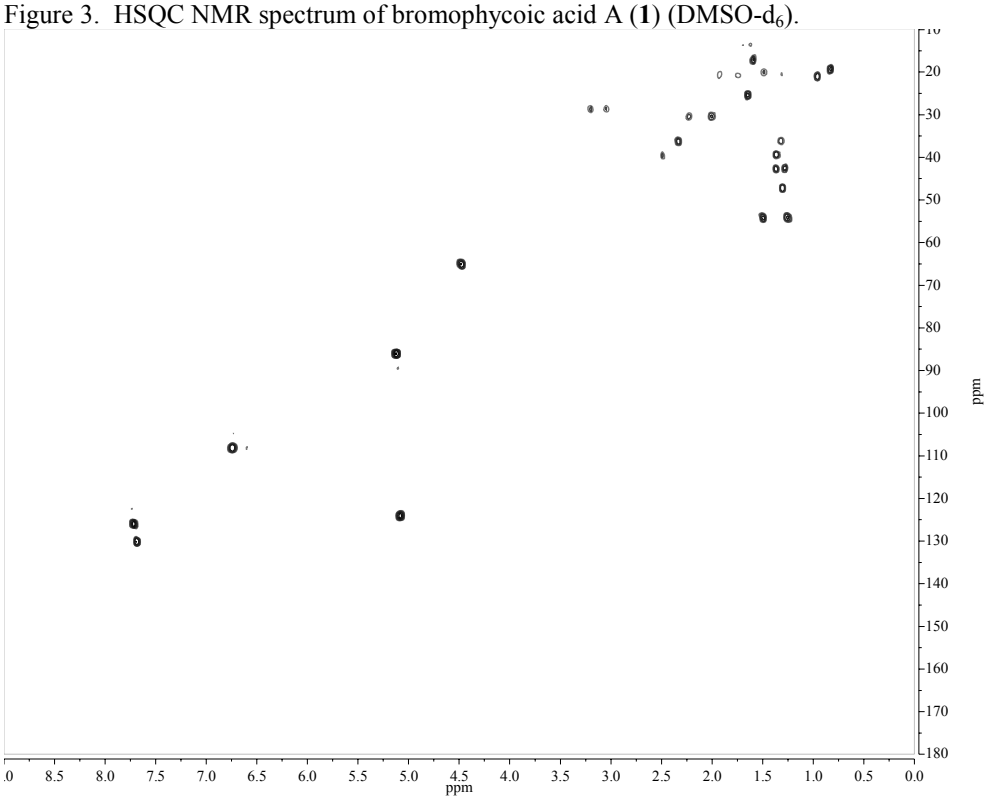

Figure 4. ^{1}H COSY NMR spectrum of bromophycoic acid A (**1**) (500 MHz; DMSO-d_6).

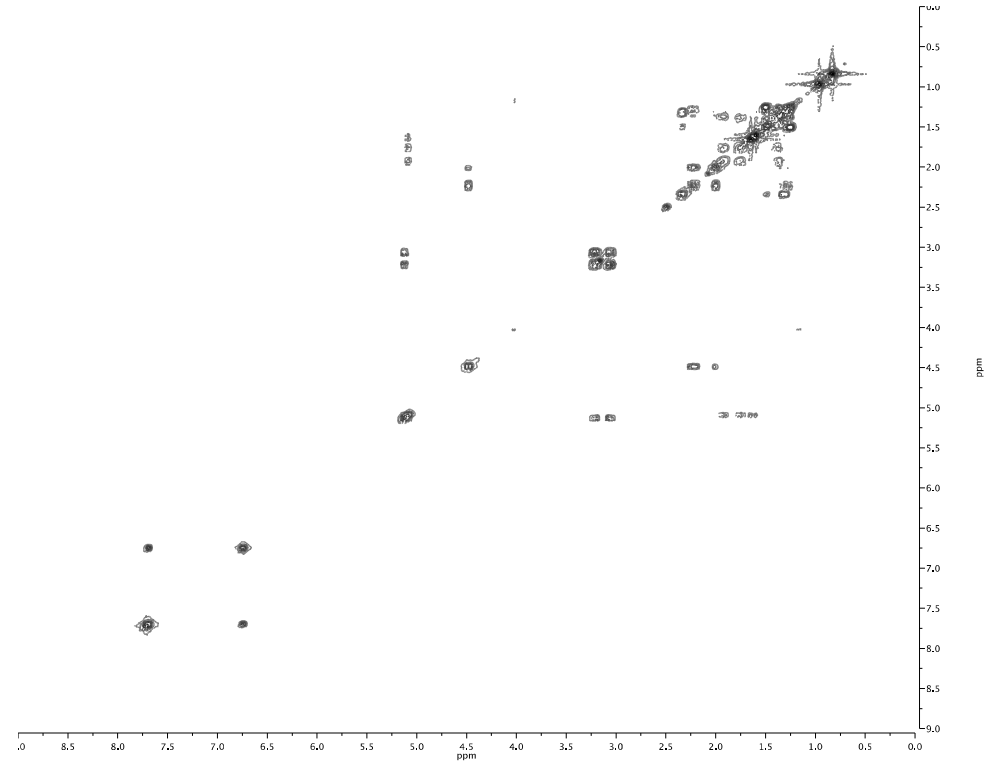

Figure 5. HMBC NMR spectrum of bromophycoic acid A (**1**) (DMSO-d_6).

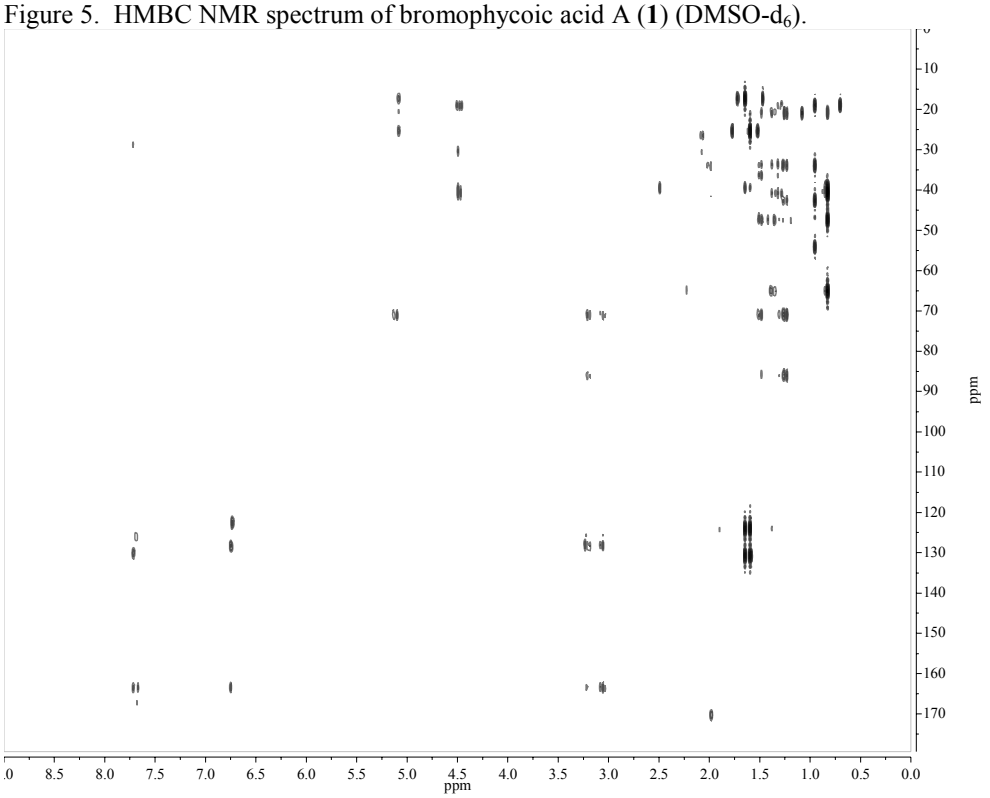

Figure 6. ROESY NMR spectrum of bromophycoic acid A (**1**) (DMSO-d_6).

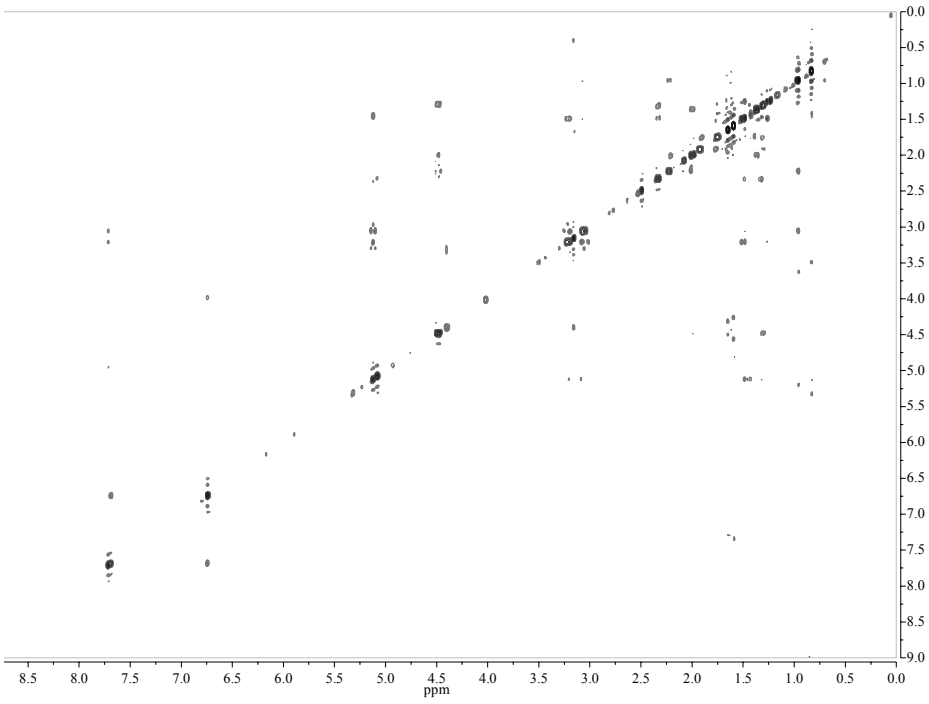

Figure 7. ^{1}H NMR spectrum of bromophycoic acid B (**2**) (500 MHz; DMSO-d_6).

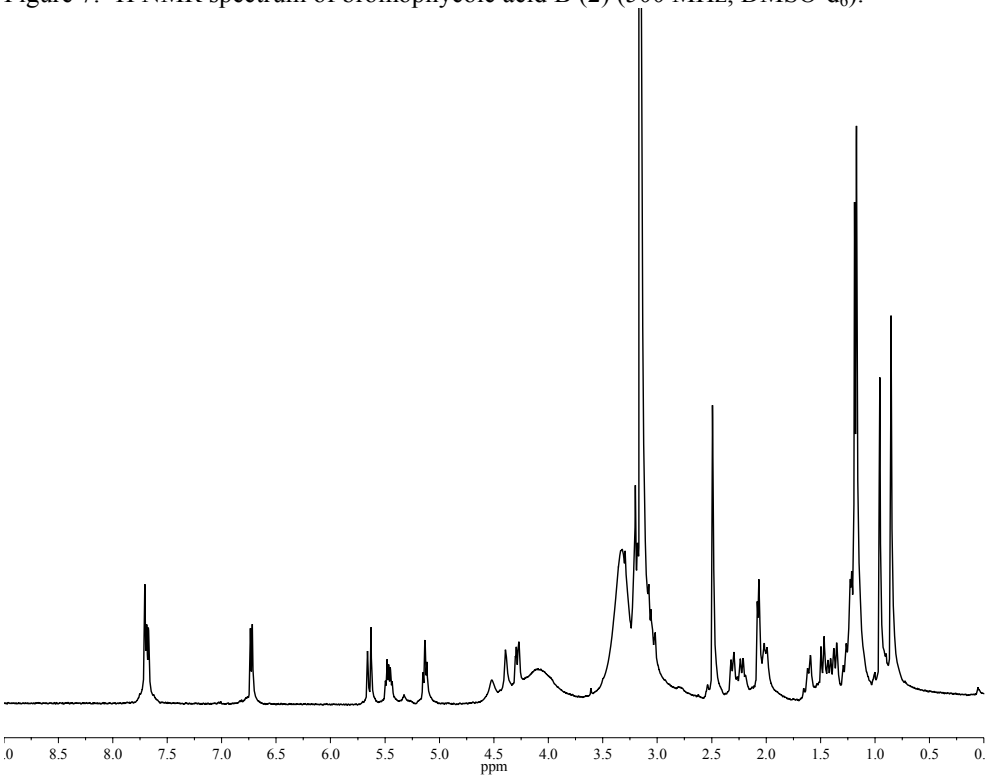

Figure 8. ^{13}C DEPT-135 NMR spectrum of bromophycoic acid B (**2**) (125 MHz; DMSO-D_6).

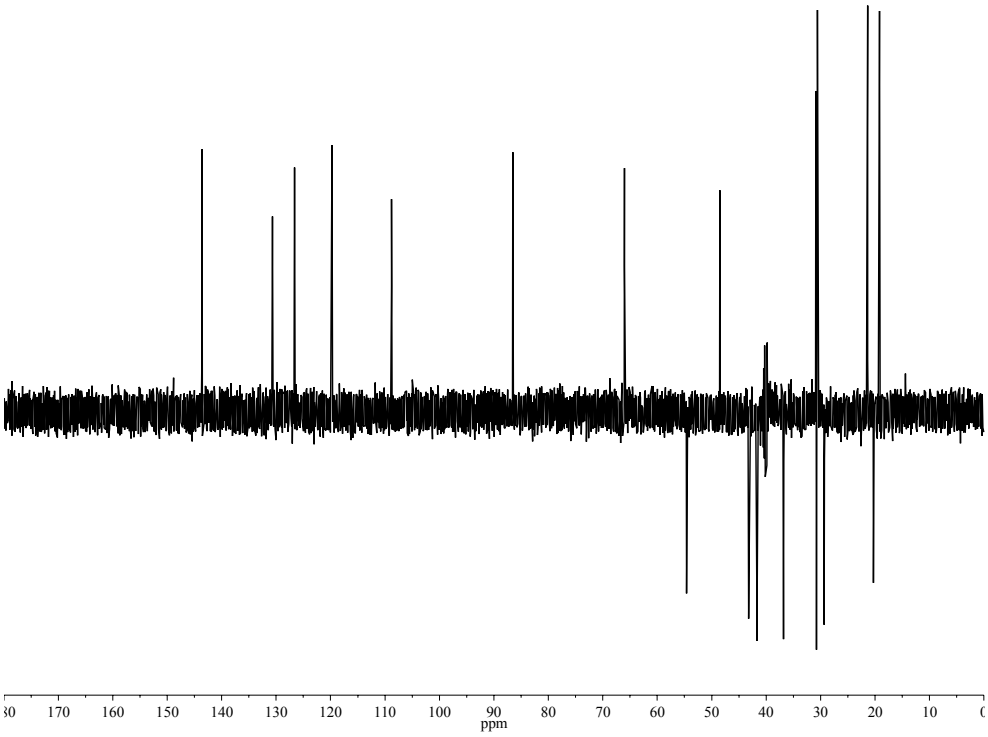

Figure 9. HSQC NMR spectrum of bromophycoic acid B (**2**) (DMSO-d_6).

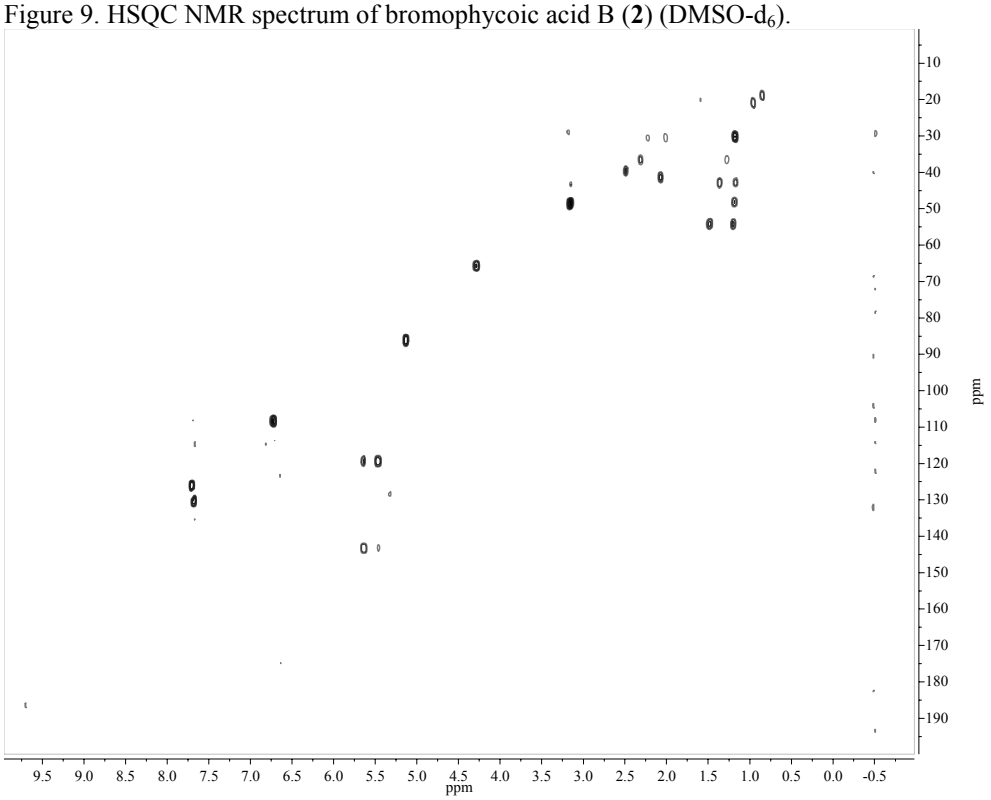

Figure 10. ^{1}H COSY NMR spectrum of bromophycoic acid B (**2**) (500 MHz; DMSO-d_6).

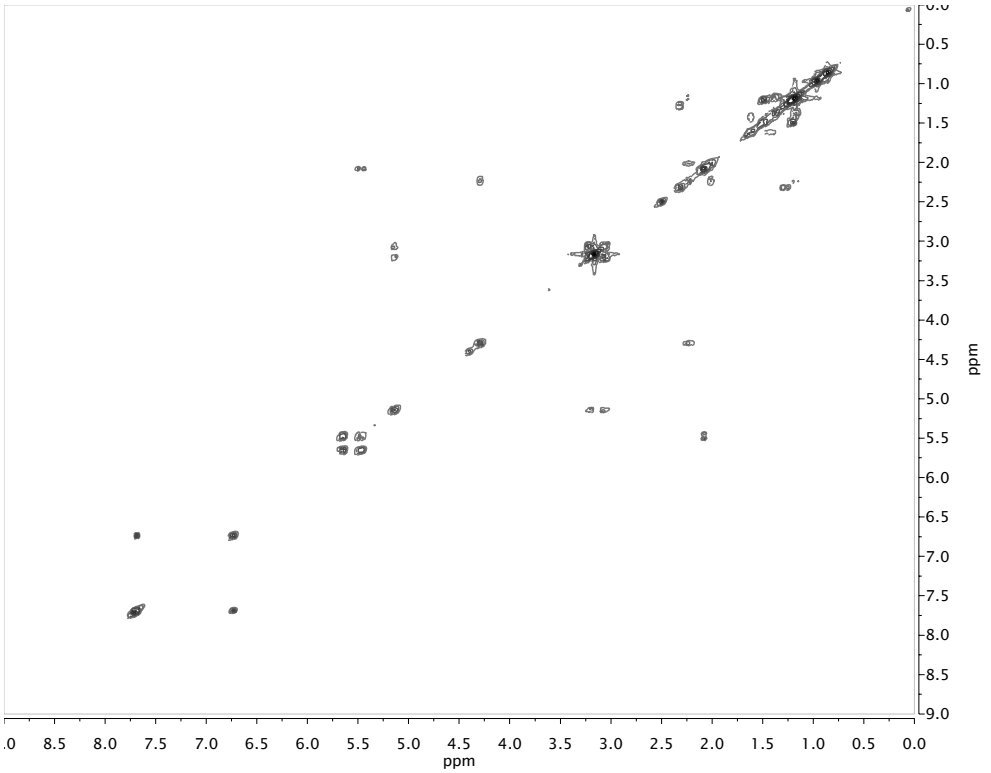

Figure 11. HMBC NMR spectrum of bromophycoic acid B (**2**) (DMSO-d_6).

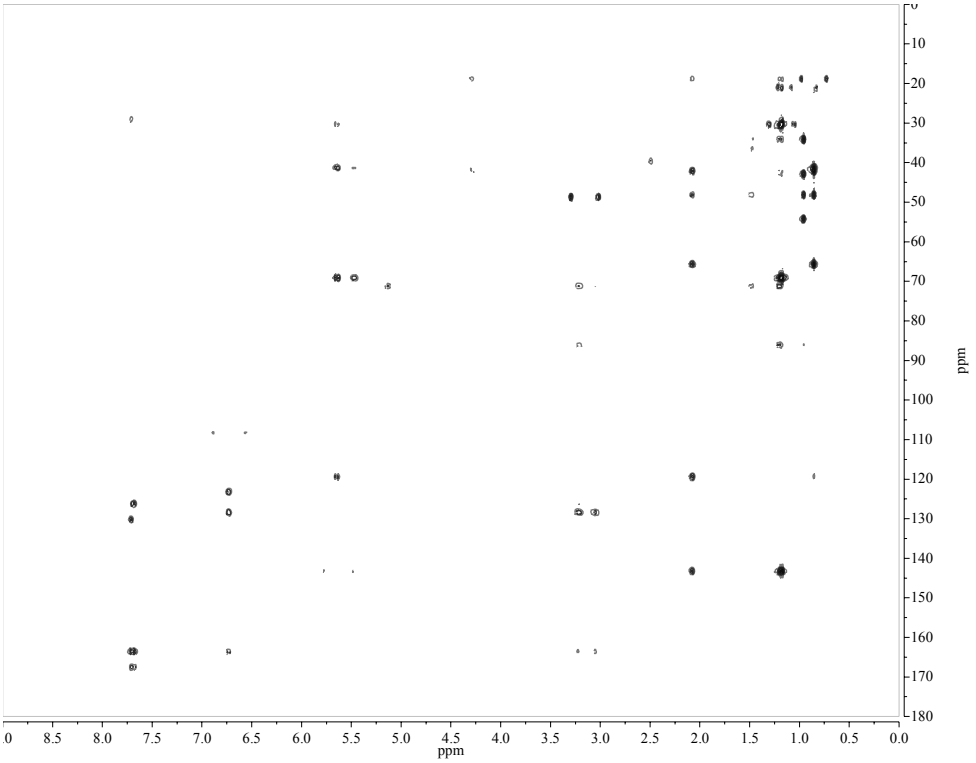

Figure 12. ROESY NMR spectrum of bromophycoic acid B (**2**) (DMSO-d_6).

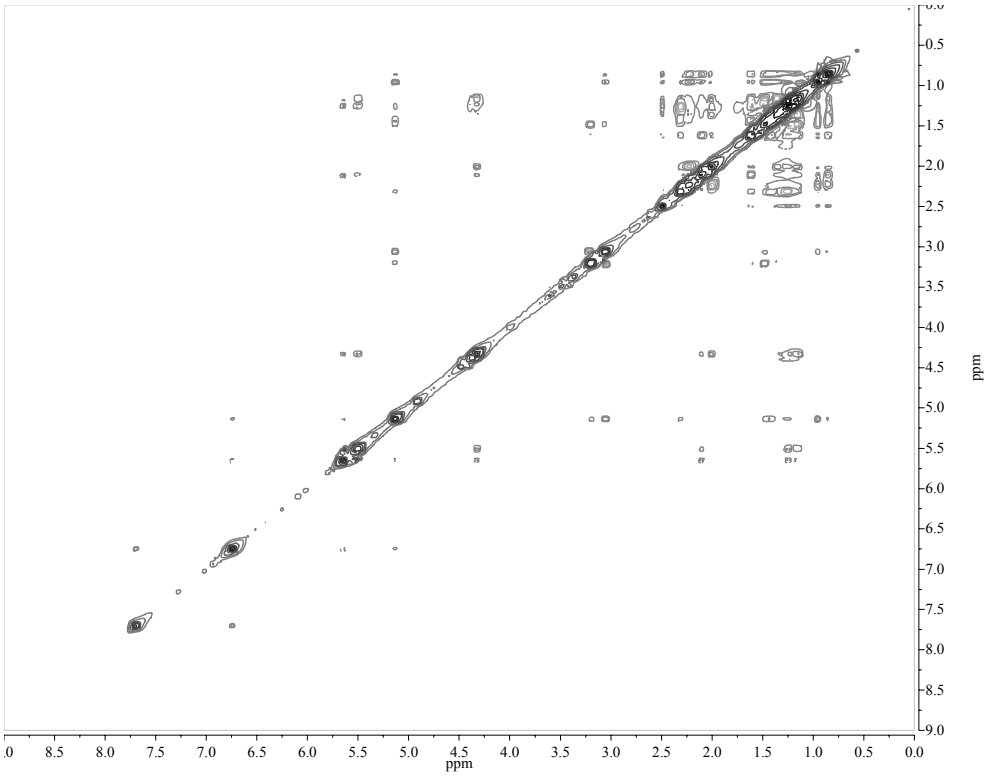

Figure 13. ^{1}H NMR spectrum of bromophycoic acid C (**3**) (125 MHz; DMSO-d_6).

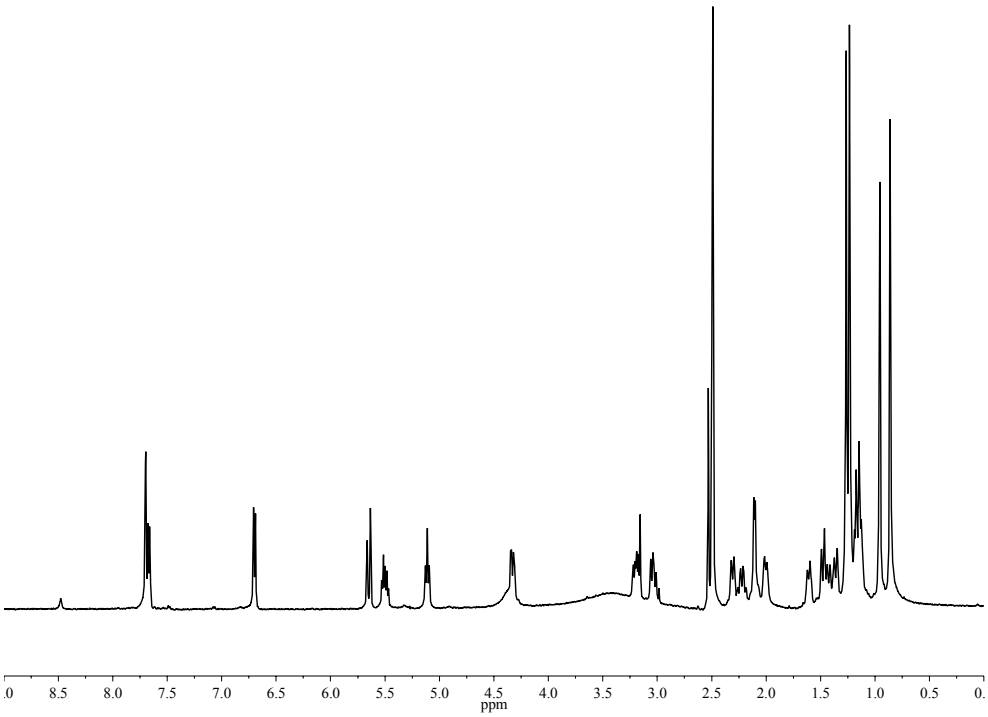

Figure 14. ^{13}C NMR spectrum of bromophycoic acid C (**3**) (125 MHz; DMSO-d_6).

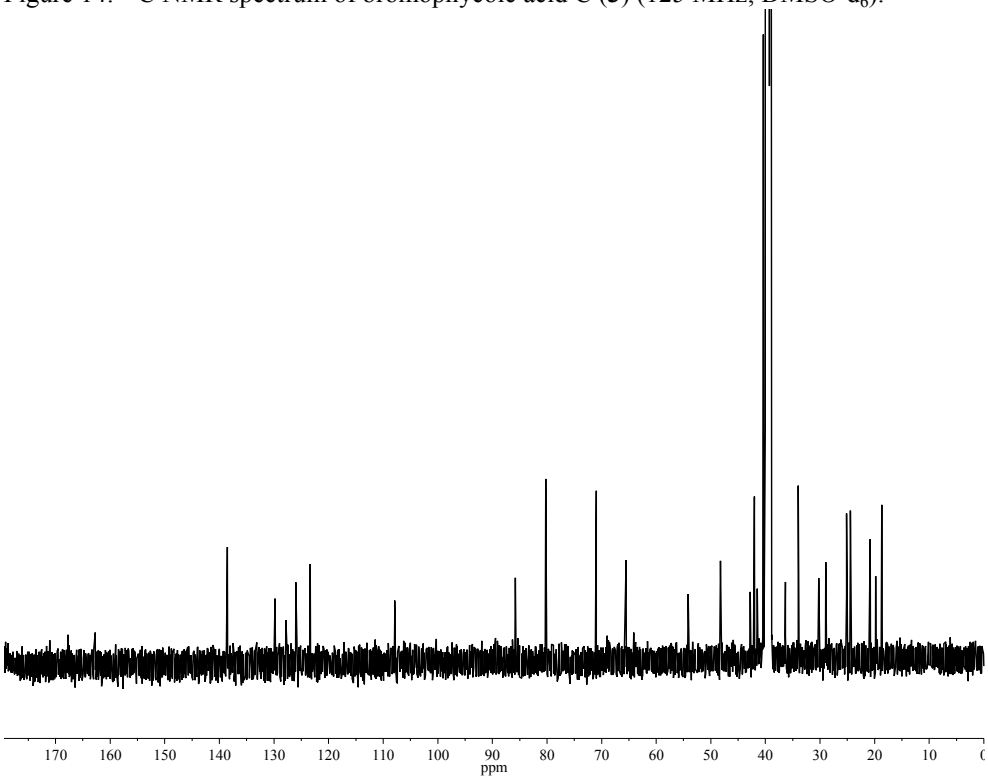

Figure 15. HSQC NMR spectrum of bromophycoic acid C (**3**) (DMSO-d_6).

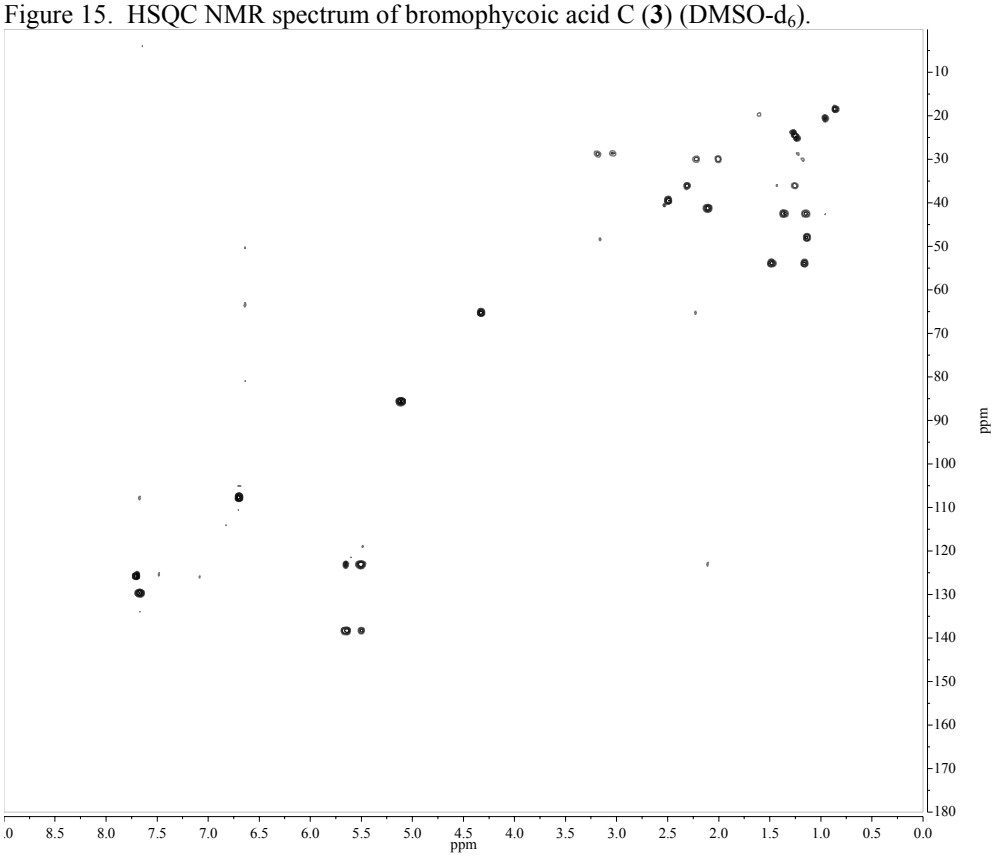

Figure 16. ^{1}H COSY NMR spectrum of bromophycoic acid C (**3**) (500 MHz; DMSO-d_6).

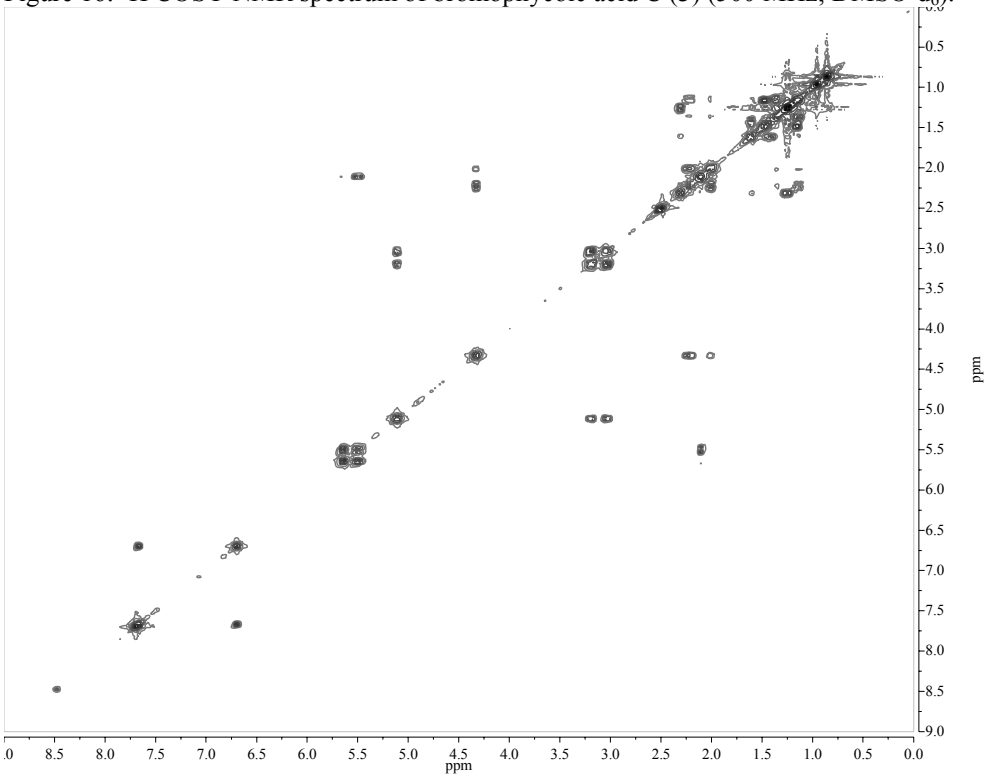

Figure 17. HMBC NMR spectrum of bromophycoic acid C (**3**) (DMSO-d_6).

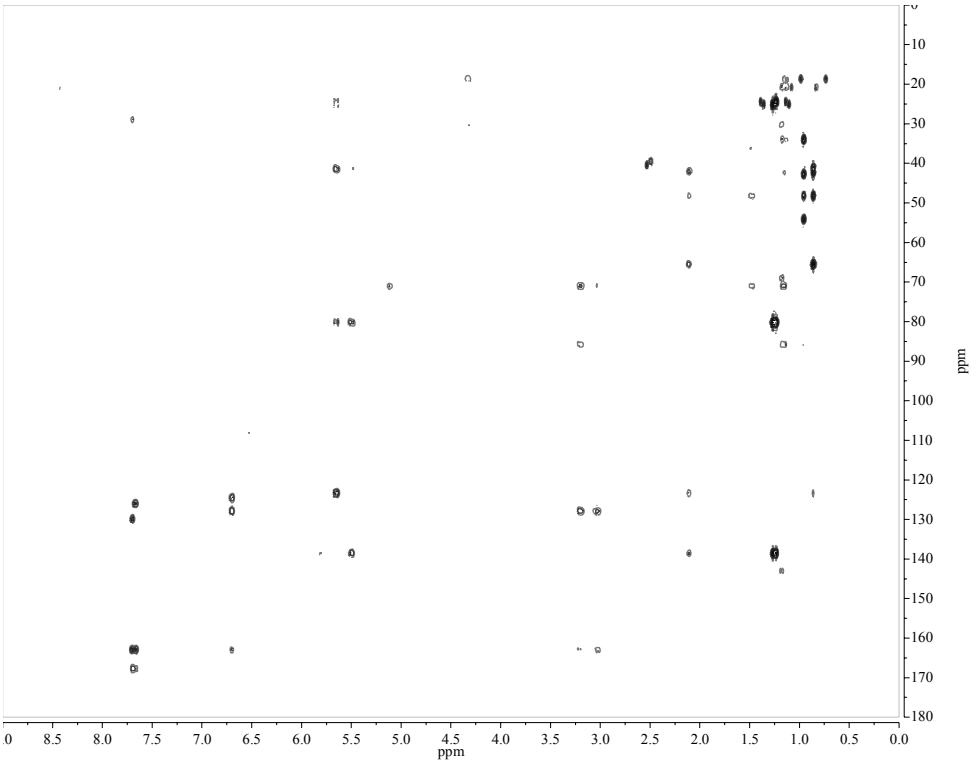

Figure 18. ROESY NMR spectrum of bromophycoic acid C (**3**) (DMSO-d_6).

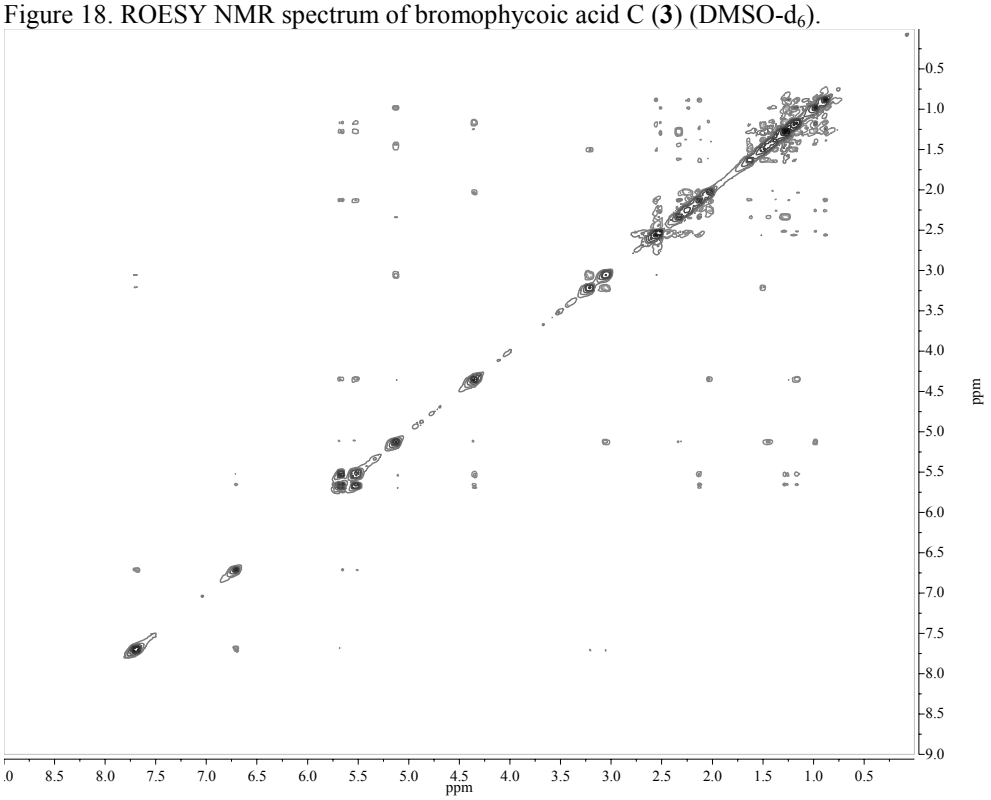

Figure 19. ^{1}H NMR spectrum of bromophycoic acid D (**4**) (500 MHz; DMSO-d_6).

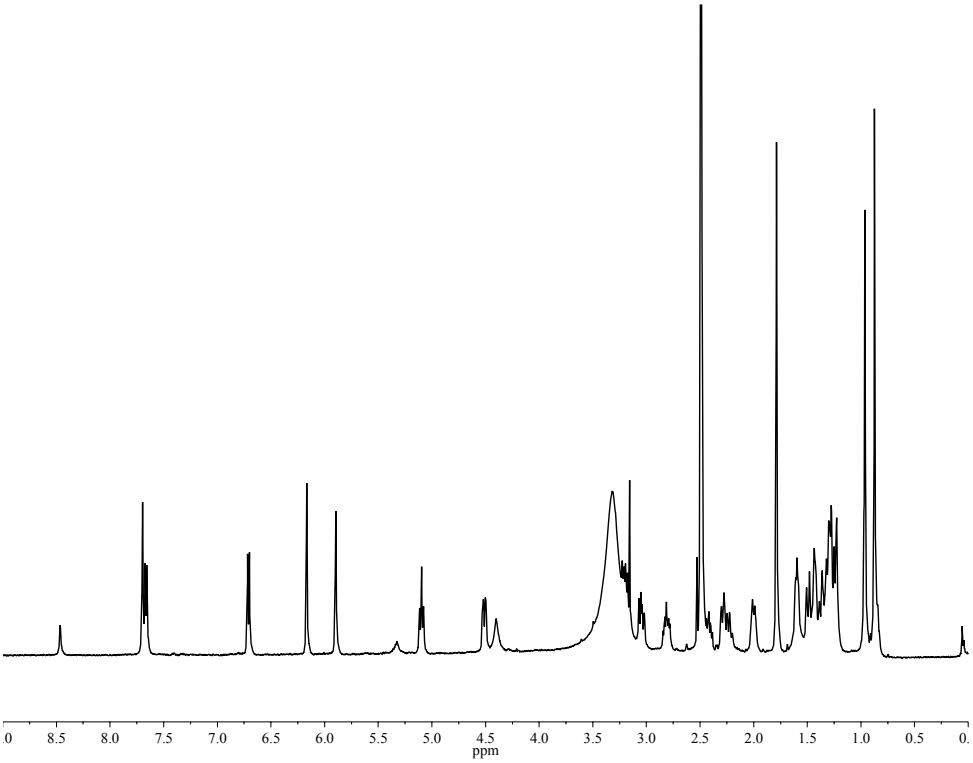

Figure 20. ^{13}C DEPT-135 NMR spectrum of bromophycoic acid D (**4**) (125 MHz; DMSO-D_6).

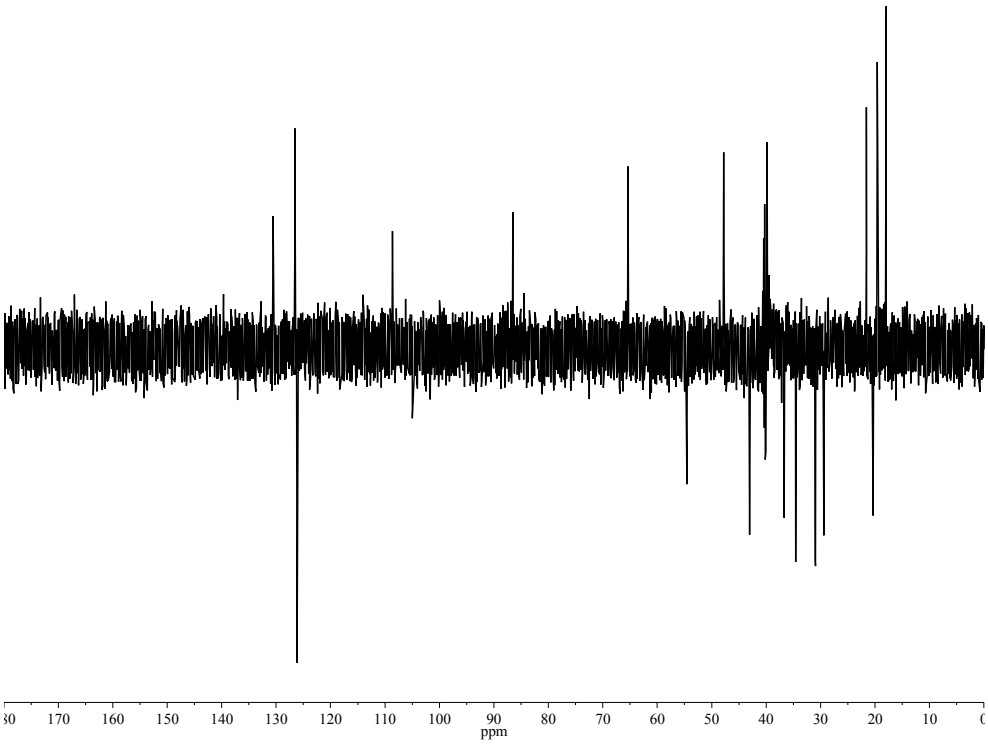

Figure 21. HSQC NMR spectrum of bromophycoic acid D (**4**) (DMSO-d_6).

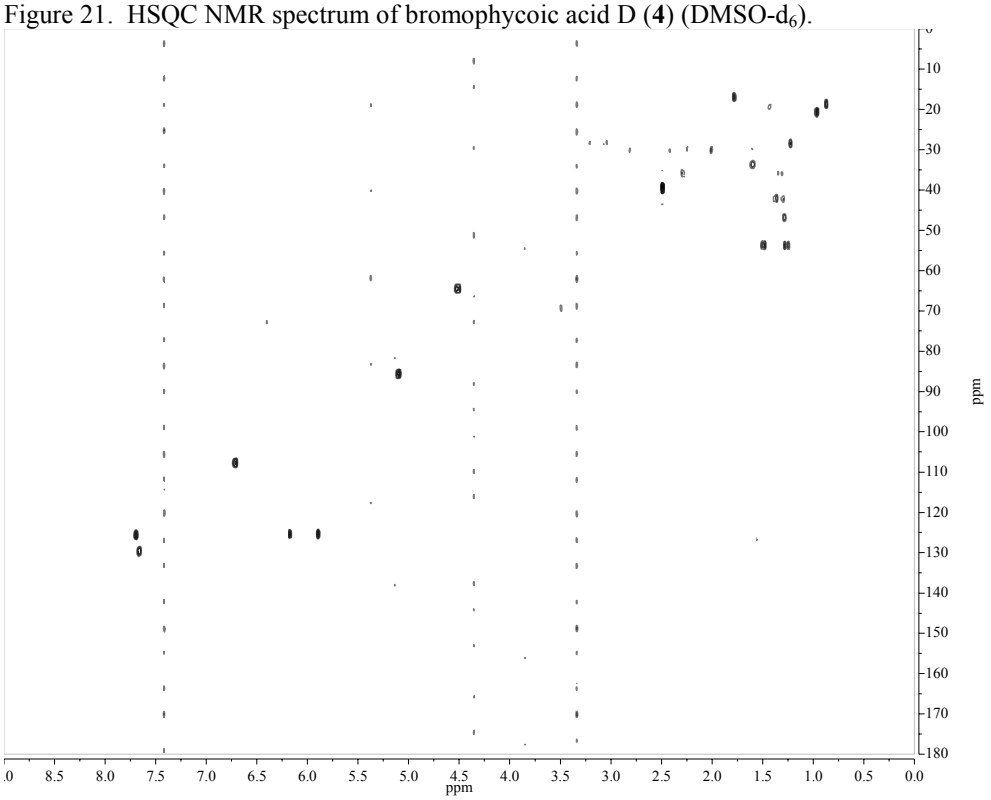

Figure 22. ^{1}H COSY NMR spectrum of bromophycoic acid D (**4**) (500 MHz; DMSO-d_6).

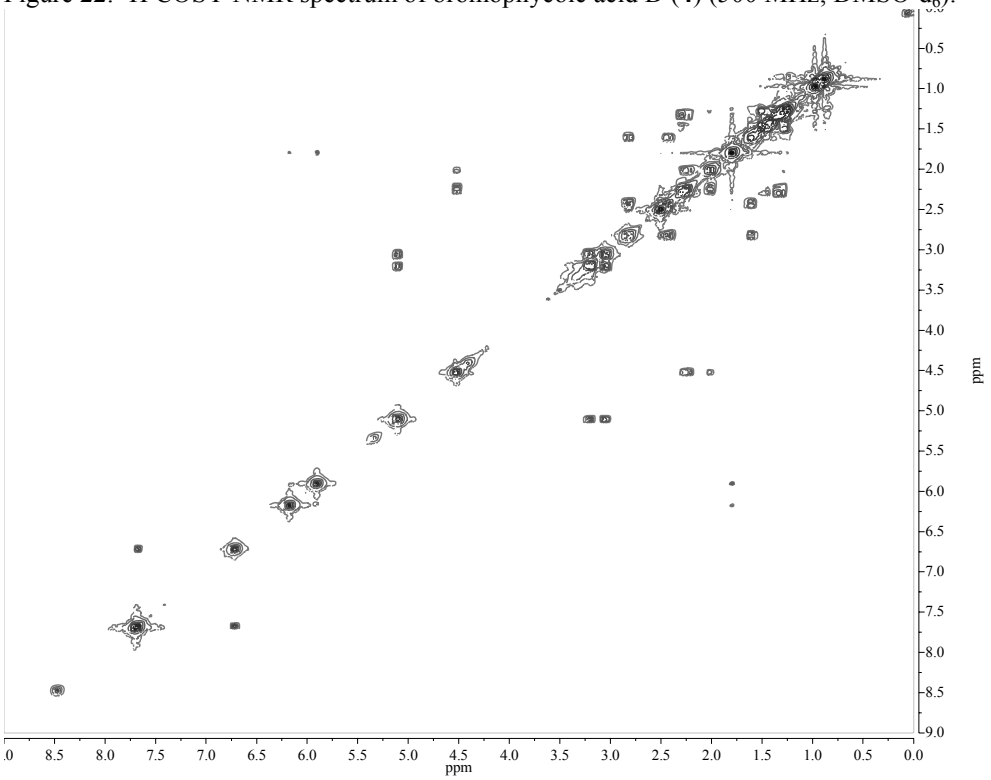

Figure 23. HMBC NMR spectrum of bromophycoic acid D (**4**) (DMSO-d_6).

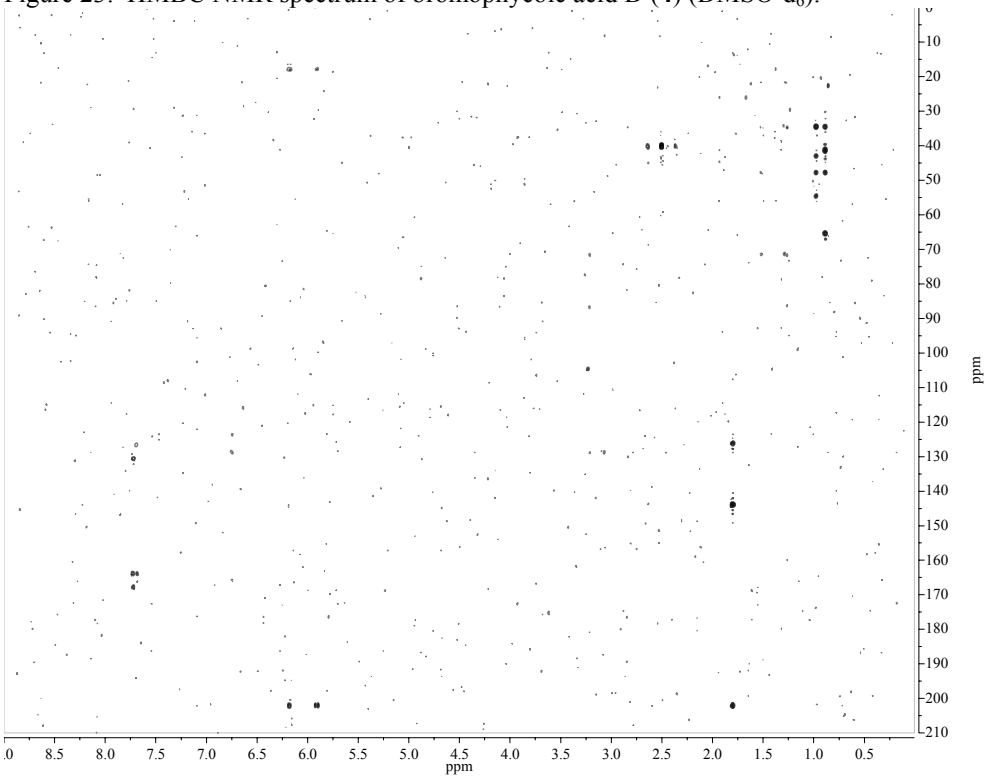

Figure 24. ROESY NMR spectrum of bromophycoic acid D (**4**) (DMSO-d_6).

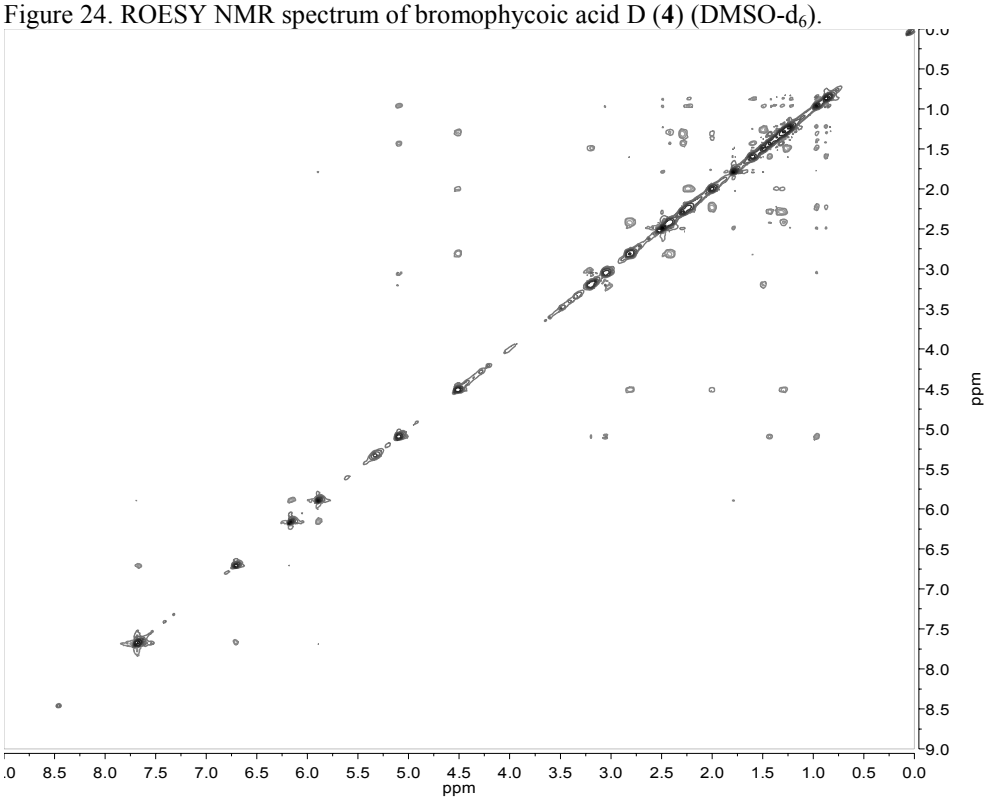

Figure 25. ^{1}H NMR spectrum of bromophycoic acid E (**5**) (500 MHz; $CDCl_3$).

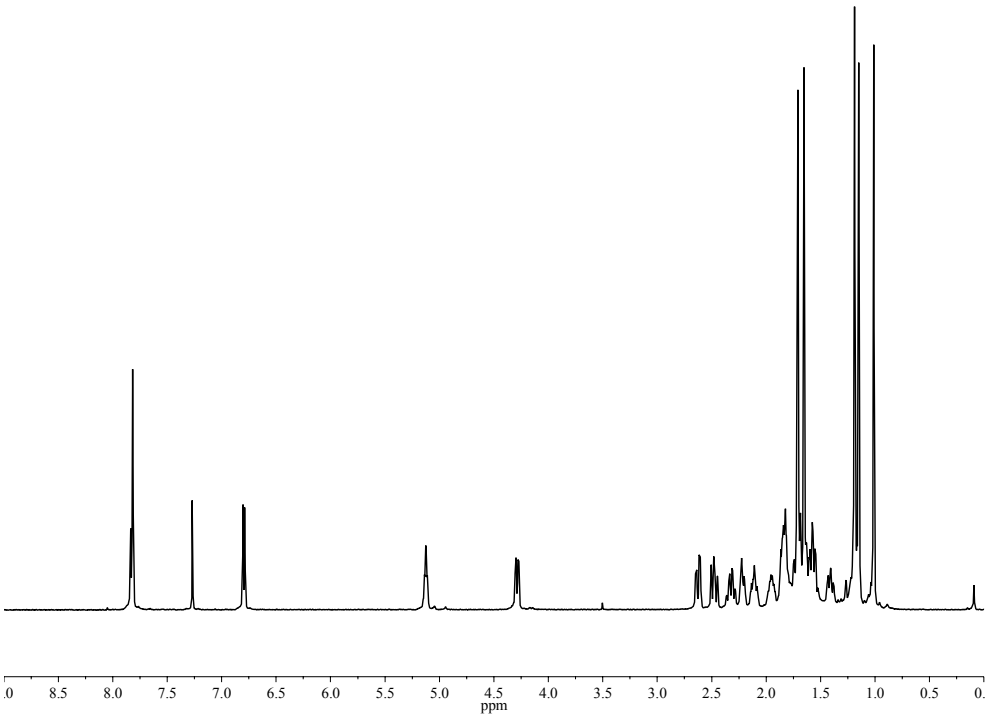

Figure 26. ^{13}C NMR spectrum of bromophycoic acid E (**5**) (125 MHz; $CDCl_3$).

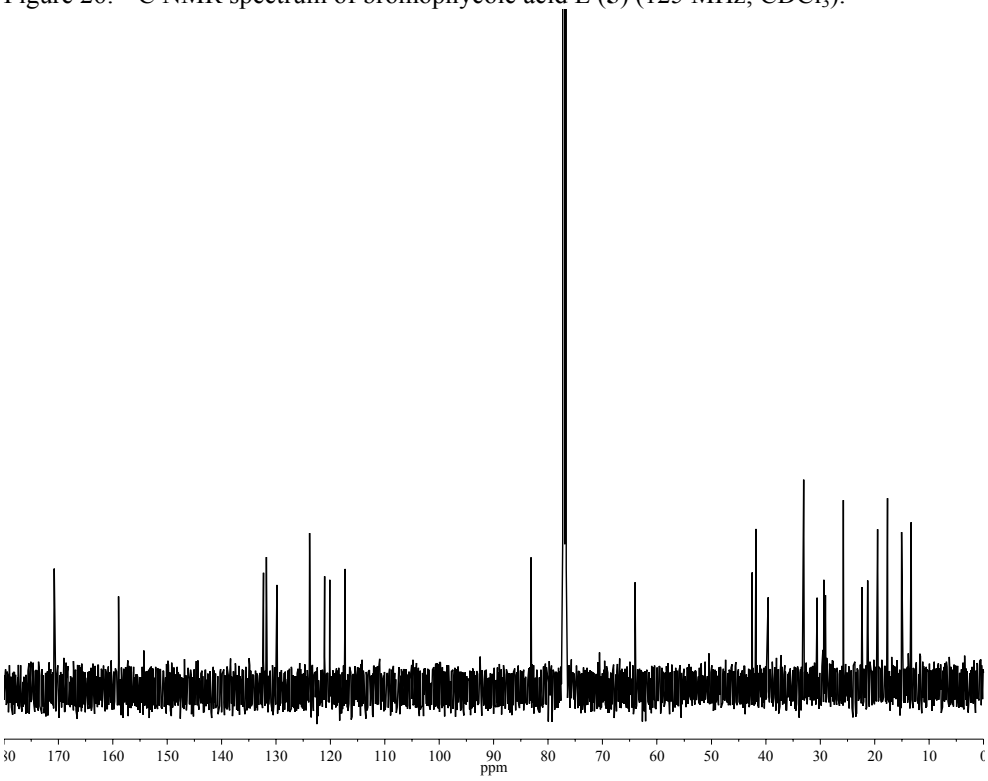

Figure 27. DEPT-135 spectrum of bromophycoic acid E (**5**) (125 MHz; $CDCl_3$).

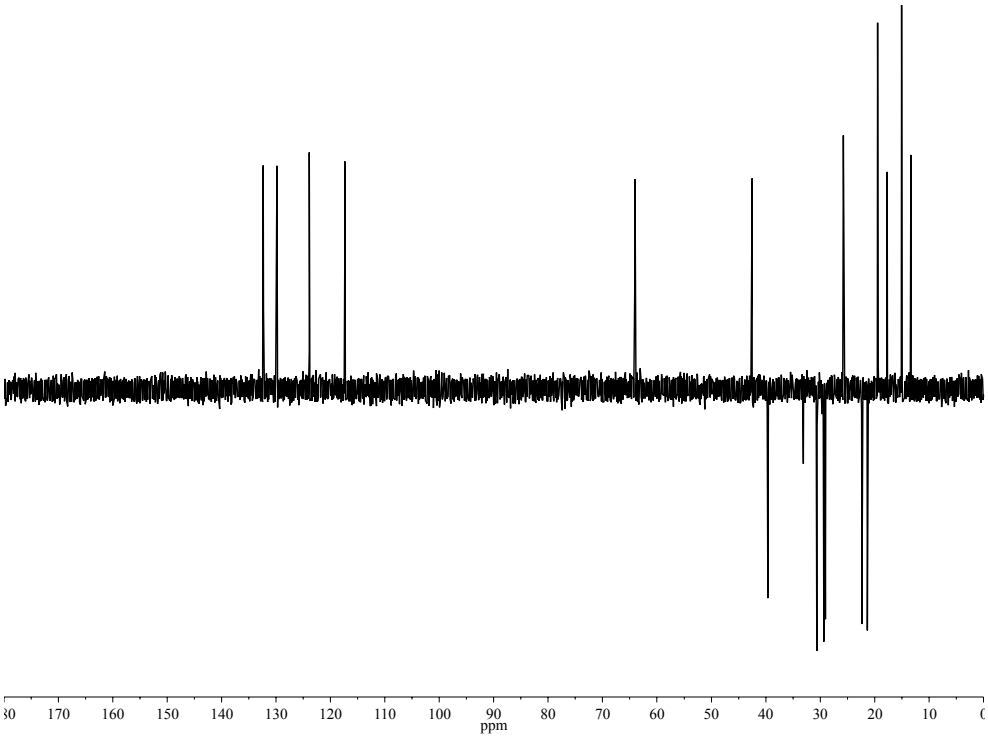

Figure 28. HSQC NMR spectrum of bromophycoic acid E (**5**) ($CDCl_3$).

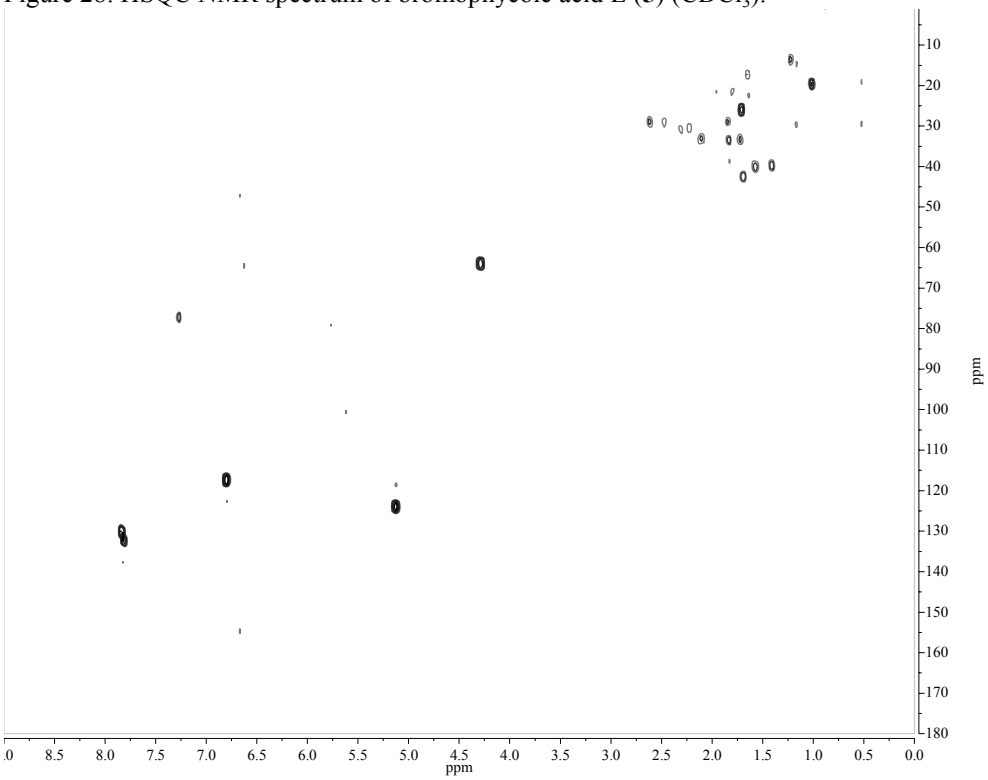

Figure 29. ^{1}H COSY NMR spectrum of bromophycoic acid E (**5**) (500 MHz; $CDCl_3$).

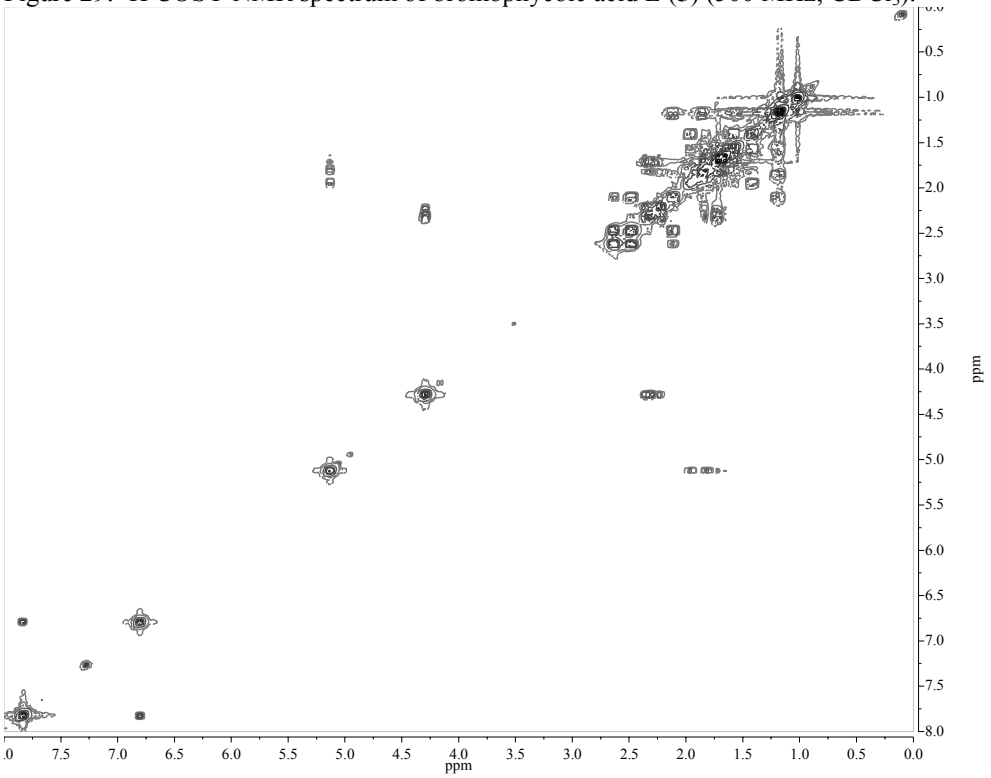

Figure 30. HMBC NMR spectrum of bromophycoic acid E (**5**) ($CDCl_3$).

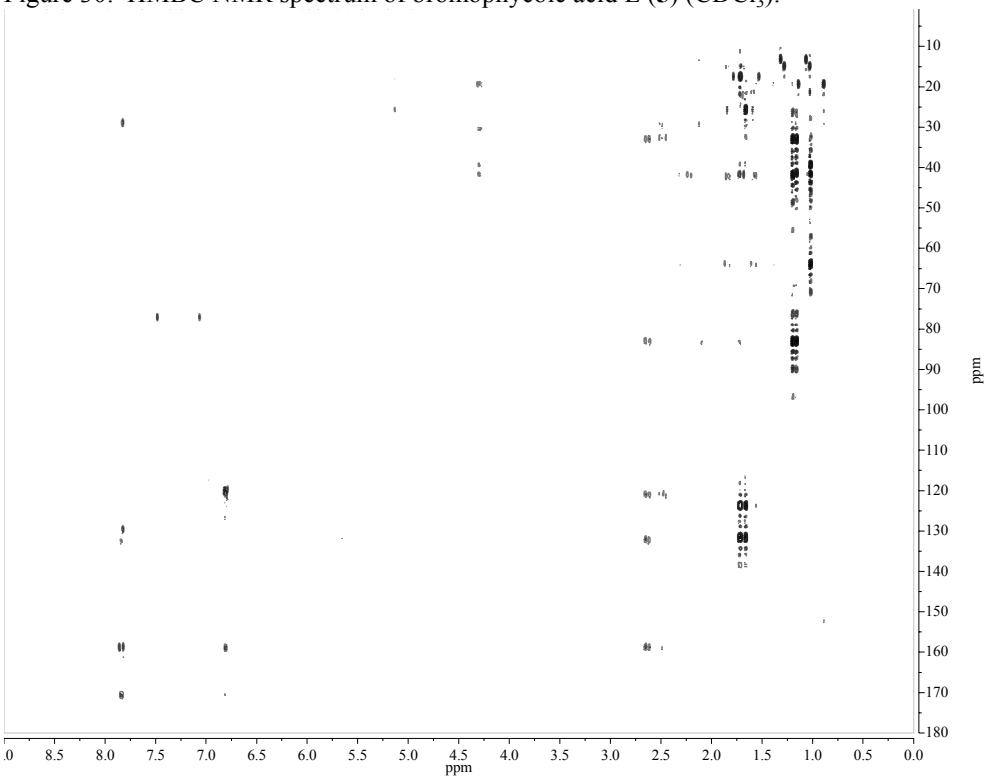

Figure 31. HSQC-TOCSY NMR spectrum of bromophycoic acid E (**5**) ($CDCl_3$).

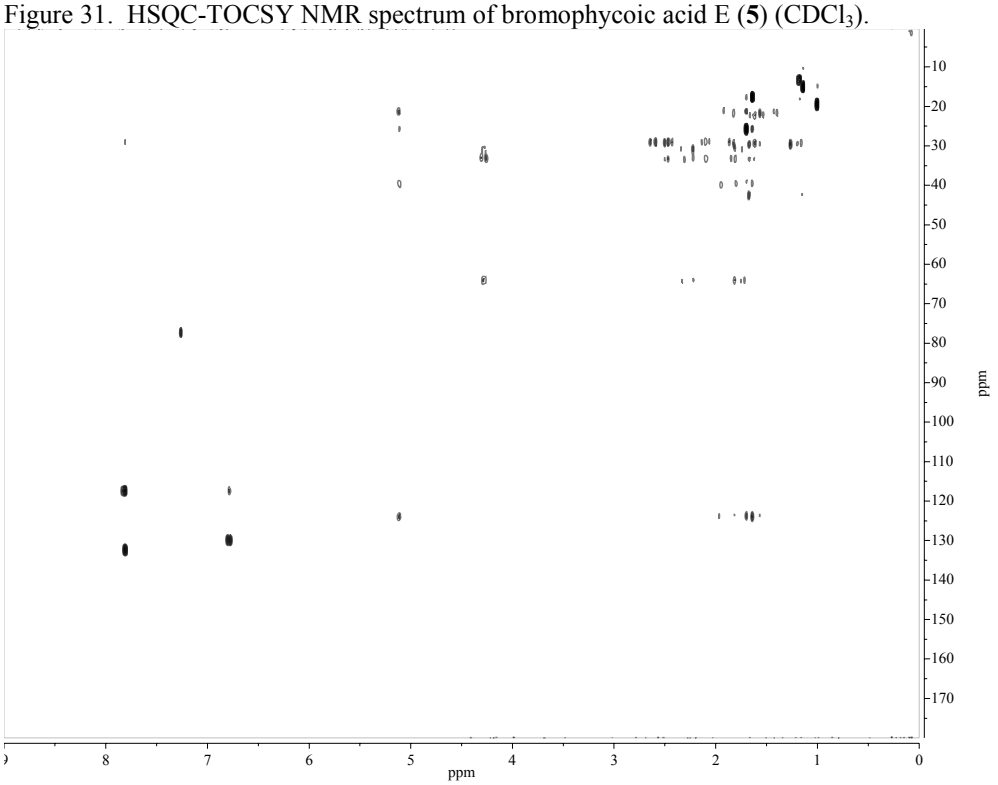

Figure 32. ROESY NMR spectrum of bromophycoic acid E (**5**) ($CDCl_3$).