

Supporting Information

Table S1. Primers for cloning into the USER version of the vector pEAQ.

	Forward and reverse primers
<i>TgTPS2</i>	F: 5'-GGCTTAAUATGGCTGTGTATGTAACTCTACAACAG-3' R: 5'-GGTTTAAUTTATGCTGGAATGGGATTTATGAGAACCGAGGT-3'
<i>TgCYP76AE1</i>	F: 5'-GGCTTAAUATGGACTGGAACGAGAACTATGTCATTT-3' R: 5'-GGTTTAAUTTATCATGTCTGACTTTGGTTTTGGAATTGCTTG-3'
<i>TgCYP76AE2</i>	F: 5'-GGCTTAAUATGGAGTGGAACTGGA ACTATGTTACGT-3' R: 5'-GGTTTAAUTTATGGCAAATTCCTTCTTCGTGTTGGAACAGC-3'
<i>TgCYP76AE8</i>	F: 5'-GGCTTAAUATGGAGTGGATGTGGA ACTATGTTGTTT-3' R: 5'-GGTTTAAUTTATGCAGCCATTCGTTTTGGA ACTGCTCTCAA-3'
<i>TgCYP76AF7</i>	F: 5'-GGCTTAAUATGGAATATTACCATGCTTTAGTTACAT-3' R: 5'-GGTTTAAUTTAGTTATTTCTAGGTGTTGGAACAAGAAGCAG-3'
<i>TgCYP76B79</i>	F: 5'-GGCTTAAUATGGATTAAATATAGTTATGATCGGTG-3' R: 5'-GGTTTAAUTTAAGGAACA ACTGAAGTTGCTACAACACGAAG-3'
<i>TgCYP71AH8</i>	F: 5'-GGCTTAAUATGGGTTTTCAATTTCTTGACAACCT-3' R: 5'-GGTTTAAUTTACTAACTATAACACGTACGGTGAAGCAACAAG-3'
<i>TgCYP71AJ5</i>	F: 5'-GGCTTAAUATGATGATGGACCAGCAAACCCTGTTTC-3' R: 5'-GGTTTAAUTTAGACTCGTGATGTCTGCAATCACCAAAGAGG-3'
<i>TgCYP71AJ14</i>	F: 5'-GGCTTAAUATGATACTAGATCAACAATTCTTGTTTC-3' R: 5'-GGTTTAAUTTAGATACGTGGCGTTGCAATCACCAACAGAGG-3'
<i>TgCYP71AT12</i>	F: 5'-GGCTTAAUATGGCTCCATTTATTTCTATCTTCTTC-3' R: 5'-GGTTTAAUTTATCAGTTATACTTCTTGGCTACTAGACGTAG-3'
<i>TgCYP71AU8</i>	F: 5'-GGCTTAAUATGCCTGCTCATTTGGGGCAACAAGCAA-3' R: 5'-GGTTTAAUTTAGATAGAAATATGGAATTGCGACAGCGAGAAG-3'
<i>TgCYP71AU90</i>	F: 5'-GGCTTAAUATGGTTTTTCATTACAGGAGACGCAAGAT-3' R: 5'-GGTTTAAUTTAGCAGCAACACGAAGTTGCAACAGCAAGGAG-3'

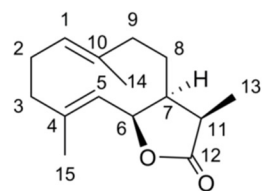
<i>TgCYP71BK1</i>	F: 5'-GGCTTAAUATGGGGTACCAGTCTGTAACATTAACAC-3' R: 5'-GGTTTAAUTTATGGTTGGTATTTGGTAGGCACAAGGTAGAG-3'
<i>TgCYP71BK6</i>	F: 5'-GGCTTAAUATGGAAATGTTCTCTGAATCTTTAAGCT-3' R: 5'-GGTTTAAUTTACTCTGTTTGGATTTCATGCTTGATCGGTAC-3'
<i>TgCYP71D183</i>	F: 5'-GGCTTAAUATGGCTCTCCAGTTGGTGCCCTTATTTC-3' R: 5'-GGTTTAAUTTAATTTTCGAGGGTAGAAATATAAGGATTTGC-3'
<i>TgCYP71D311</i>	F: 5'-GGCTTAAUATGGAGTTTCAATATCCAACCTCATTTCG-3' R: 5'-GGTTTAAUTTAAGGCTTCTAGGTAGGGCGGGAACCAGAACC-3'
<i>TgCYP71319</i> ortholog	F: 5'-GGCTTAAUATGGAGATTTACTCACCTATTCTTGCCC-3' R: 5'-GGTTTAAUTTAAGCCTTCTGAGCTGCATATTCAGCGGTGGG-3'
<i>TgCYP71AS14</i>	F: 5'-GGCTTAAUATGGAAATCTTTTCGGAATCTCTGAACT-3' R: 5'-GGTTTAAUTTACTCTGTTTGGATTTCATGCTTGATCGGTAC-3'
<i>TgCYP706C30</i> ortholog	F: 5'-GGCTTAAUATGTTTAAGGATATACAAGCCACTGTCT-3' R: 5'-GGTTTAAUTTACTGGTAGAGCTCAGGATTAGATAATCTCGC-3'

Table S2. In tube *in situ* primers. Primers are specific for *TgTPS2* and *TgCYP76AE2*.

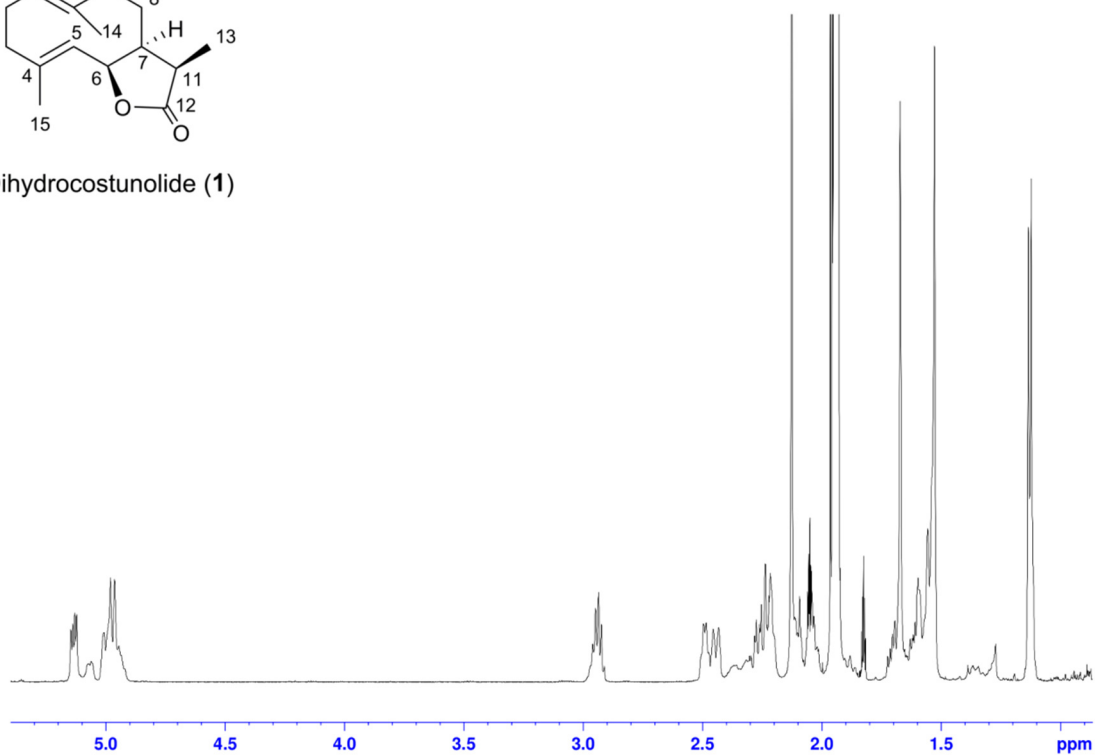
Gene	Primer sequence
18S	F: 5'-CGGGGAAACTTACCAGGTCC-3' R: 5'-TAAGAAGCTGGCCGTGAAGG-3'
<i>TgTPS2</i>	F: 5'-GGTGATTTGCAGACTCAGTGAC-3' R: 5'-TTATGCTGGAATGGGATTTATGAG-3'
<i>TgCYP76AE2</i>	F: 5'-CAGACGTTTCACGCTCCCTC-3' R: 5'-CCATGACATCATCTCATCTGCAC-3'

Figure S1. ^{13}C and ^1H NMR spectra of product **1**, **2** and **3**.

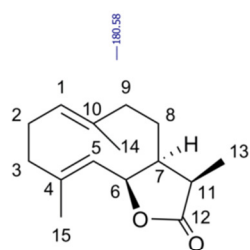
1D Proton Spectrum of dihydrocostunolide (1) in MeCN- d_3



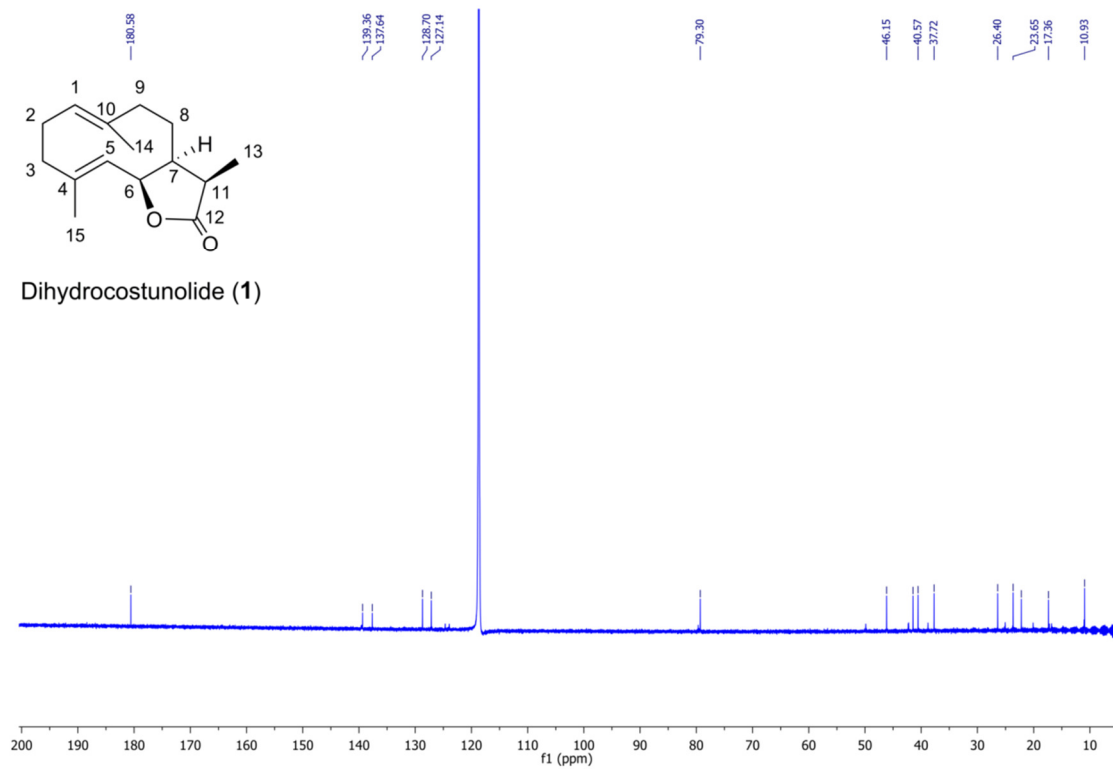
Dihydrocostunolide (**1**)



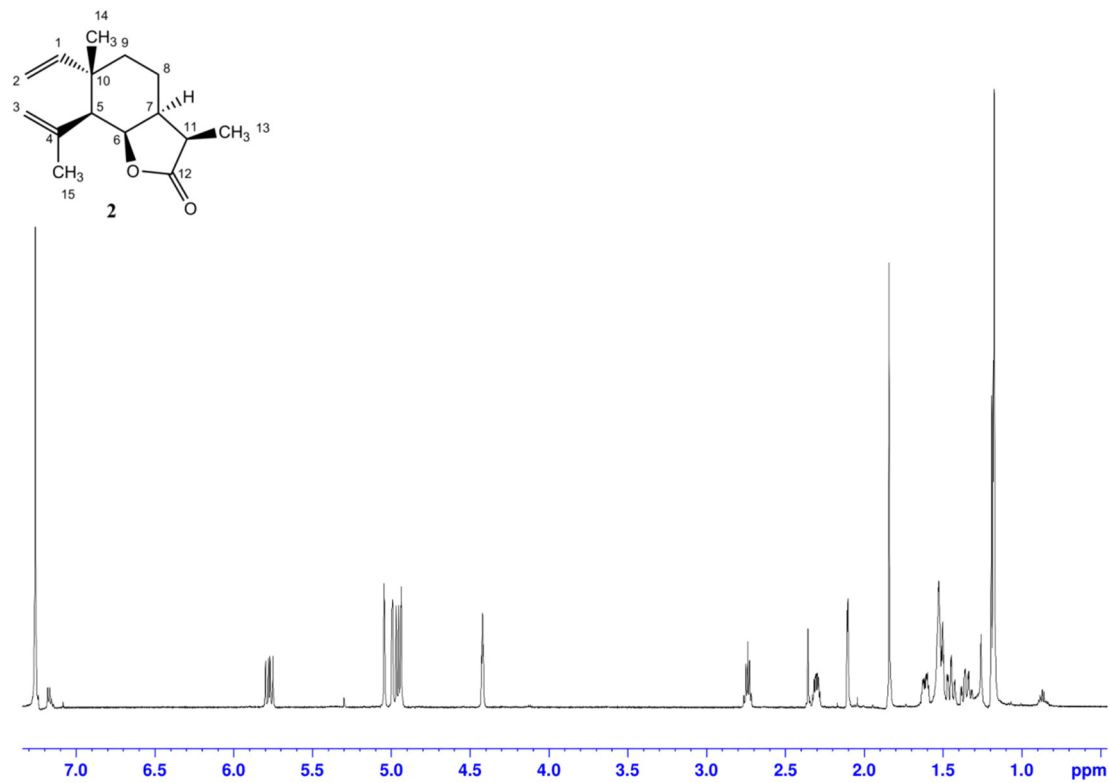
1D Carbon Spectrum of dihydrocostunolide (1) in MeCN- d_3



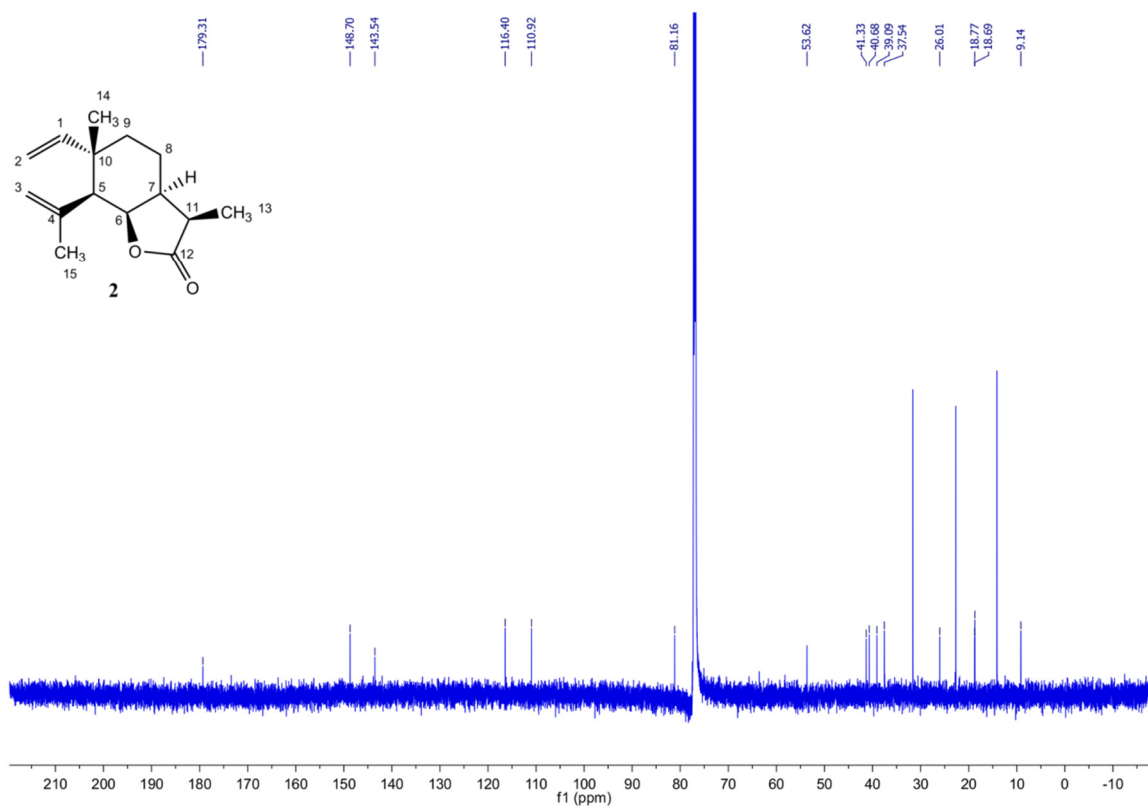
Dihydrocostunolide (**1**)



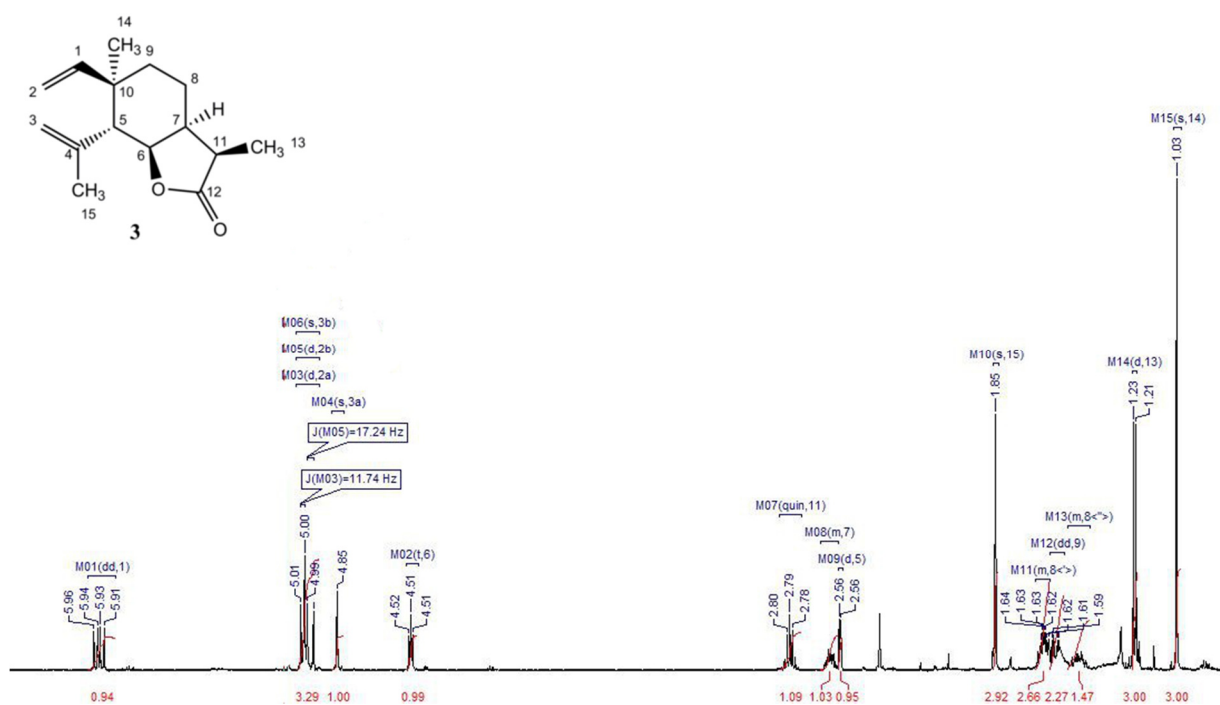
1D Proton Spectrum of 2 in Chloroform-d₁



1D Carbon Spectrum of 2 in Chloroform-d₁



1D Proton Spectrum of 3 in Chloroform-d₁



1D Carbon Spectrum of 3 in Chloroform-d₁

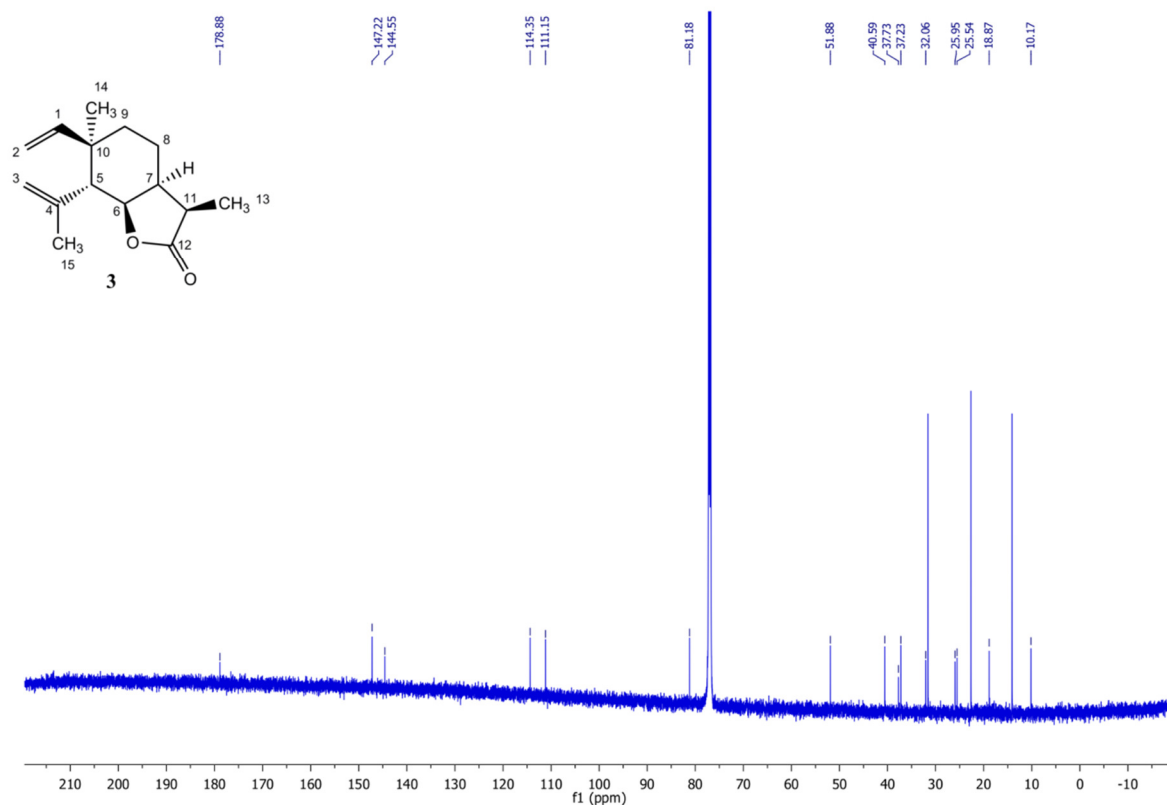


Figure S2. Cope-rearrangement of **1** upon GC-MS analysis. *denotes column contamination.

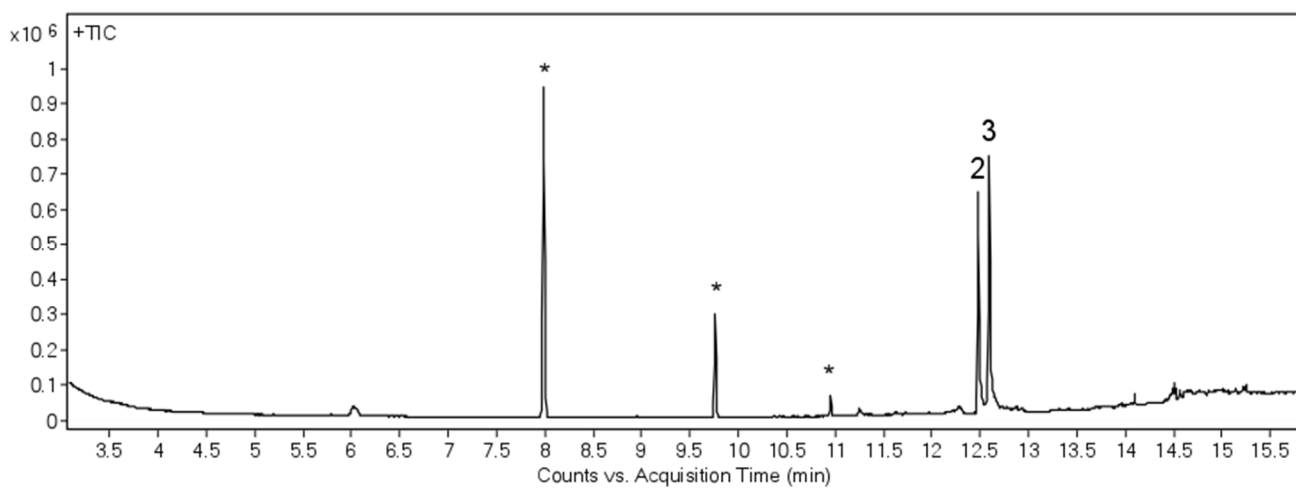


Figure S3. MALDI-MSI analysis of *T. garganica* taproot section and structures of metabolites. **A:** optical image of taproot section with DHB matrix applied by spray deposition, **B:** distribution of thapsigargin K adduct, $[M+K]^+$ m/z 661.26040 (calc. 661.26209, 0.01 ppm error), **C:** distribution of nortrilobolide K adduct, $[M+K]^+$ m/z 547.19380 (calc. 547.19401, 0.38 ppm error), **D:** distribution of trilobolide K adduct, $[M+K]^+$ m/z 561.20730 (calc. 561.20966, 0.01 ppm error), **E:** distribution of thapsivillosin I K adduct, $[M+K]^+$ m/z 645.2327 (calc. 645.23079, 2.97 ppm error), **F:** distribution of thapsivillosin L K adduct, $[M+K]^+$ m/z 633.23240 (calc. 633.23079, 2.55 ppm error). Images normalized to RMS and scaled to 0-60 % of maximum signal intensity using FlexImaging 4.1 to enhance visualization. Results demonstrate thapsigargin and related metabolites to be localized to concentric circles of secretory ducts.

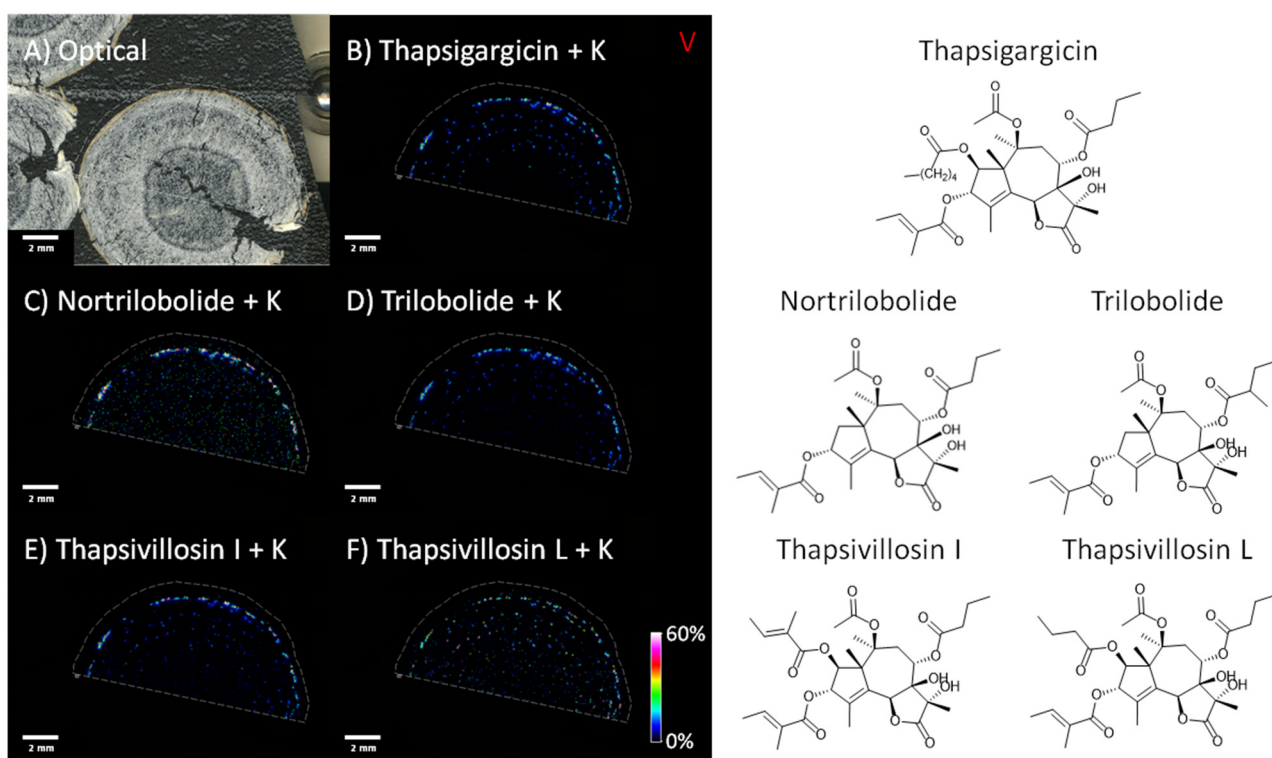


Figure S3-2: MALDI-MSI analysis of *T. gargarica* taproot section. Images normalized to RMS and scaled between 0-100% of maximum signal intensity using FlexImaging 4.1 to enhance visualization. Metabolites and lipids were tentatively annotated using accurate mass match to LipidMaps database (www.lipidmaps.org), searching for M+H, M+Na and M+K using a mass tolerance of <0.01 m/z. Results demonstrate different ion signatures for different tissue types including epidermis, parenchyma, stele and concentric circles of secretory ducts. **A:** optical image of taproot section with sublimed DHB matrix, **B)** distribution of disaccharide K adduct localized to parenchyma, $[M+K]^+$ m/z 381.0779 (calc. 381.07937, 3.8 ppm error), **C)** distribution of thapsigargin K adduct, $[M+K]^+$ m/z 689.2924 (calc. 689.29339, 1.43 ppm error), **D)** distribution of unknown ion m/z 483.0226 localised to epidermis, **E)** distribution of tentative PC(34:2) H adduct, $[M+H]^+$ m/z 758.5637 (calc. 758.5695, 7.6 ppm error), **F)** distribution of tentative GlcCer(d36:1) K adduct, $[M+K]^+$ m/z 780.5421, (calc. 780.5387, 4.3 ppm), **G)** distribution of tentative SHexCer(t34:1) H adduct, $[M+H]^+$ m/z 796.5202, (calc. 796.5240, 4.7 ppm error), **H)** distribution of tentative PS(46:10) K adduct, $[M+K]^+$ m/z 950.5342, (calc. 950.5367, 2.6 ppm error), **I)** distribution of tentative DGDG(54:12) K adduct, $[M+K]^+$ m/z 1215.7350 (calc. 1215.7320, 2.5 ppm error).

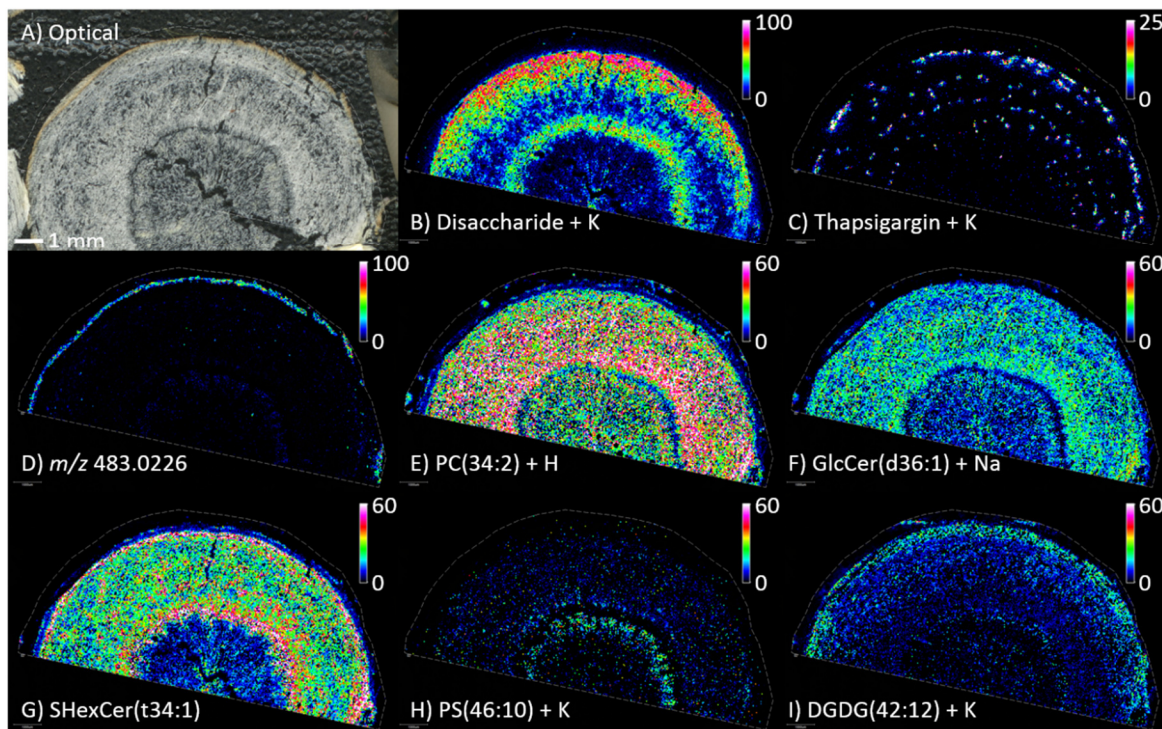


Figure S4. Alignment for the figure 2 tree. The figure also include numbers for the additional gene sequences.



210 220 230 240 250 260 270 280 290 300 310 320 330 340

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LRKRLQLLMYNNMYRIMFDRRFES EDDPLF LK L K A L N G E R S R L A Q S F D Y N Y G D F I P I L R P F L R G Y L K L C Q E I K D - - K R I K L F K D Y F V E F R K N L E S I K - - - - - R V D N N - S L K C A M D H I L E A Q - Q K G E - - - - -

FG E T A F L T S I N A M M S M L W G K Q G G E R K G A D V W G Q F R D L I T E L M V I L G K P N Y S D I F P V L A R - F D - I Q G L E K E M T K I I V N S F D K L F N S M I E E R E N F S N K L S K E D - - - G N T E T K D F L Q L L L D L K Q K N - - D S G - - - - I S

VG E Q M F L T I M N V I T N M M W G G T V K G K D R A G - L G T E F R L V N E I T L L G T P N Y S D F Y P G L A R - F D - L Q G V R K K M K V L A K K F D D F E T M I K R Q E M D - - - - - G Q E G S K D F L Q F L L K L K D T Q - D A K E - - - - - P

V G A K A F I T S L N L I T N M M W S T S T E T G E - - - R G G E F K D L V G F L V H V L G V P N A S D L F P F L E R - F D - V Q G L Y R R M E K V F V R F D K M F D G I E D K L S - - - - - G K S K K D F L Q S L L D L V E R G V D E Q D P D S V Q

V K K F M F P A I F N L I G N L T L S Q D L T H P N S K - - - M A S E F Y T A L S G F S V C L S S P N I S D L F P W L R W - L D - L Q G L R R T D R E L K K A M Q I I S G F V S E R V K Q R Q H R E G R - - - - - A T E H K - D F L D V L D Y E G N G - K D E P - - - - - A K

V R D F V F S A S F N I M G N L M L S R N L V D P Q S E - - - I S S E F C T A F A G F Q E C V G R P N I S D L I P W L R R - L D - L Q G I R K A A E F N L A K A I E I I S E F V K E R V T E R Q Q K Q - - - - - D L S E Q D F L D V L L D Y R G T G - K D E P - - - - - A K

V I N F V F S A I F N I V G N L T V S R D L V D P Q S T - - - M S S F F I N S L S G L H Q G L R L N I S D L V P C L R R - F D - I Q G I R K E L D D S L G K A I E I I S G F V K E R K E Q R R Q P L E I - - - - - S S E Q R K D F L D V L L D F R G T S - K D E P - - - - - A K

I G K L A F A T A L N Q M S N T C F S A D V A H F N S D Q - - - D G N E F Q N A V K T I M K V D G K M N F A D Y F P W L K I - L D - P Q G I R R D A K A A Y S W L D Q L C E N F V Q R L R H R E C - - - - - N F P P H G D L L D S F L D F R Q E N - - - - - P V Y

I G R A A F L T S L N L S N T I F S K D M V D S Y D N S - - - E A K L F R D L V W N S S V E S G K P N L V D Y F P I L Q W - M D - P Q G I R R L A S H F E S L I K L F D V L V D E R L E L K R P G N H G E - - - - - N T S T A - D V L D E L L K L L E T N - E - - - - -

I G A V A F L T S L N L S N T V F S K D L V E P G L G - - - A V Q E M E F V W G I T E E A G R P N L V D Y F P V L R R - L D - P Q G T R R R M M G Y F G K M F E V F G D I D E R L E L R K Q Q S D G D S P - A A T T N - D V L D V L L N I I E - D - A E I E - - - - - E K

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L S K L F V T L T N D V S C R S A F G R K Y S E E G - - - - - S G R E F N K L L K E F L E L L G S Y S F A D F V P W L G W - V D R I S G L D A K V D R V F K K L D E F L Q G V V Q E H V D K Q A M Q L G G K N S - Q S E H K E D F V D I L L R I Q N - E - T T H G - - - - - I S

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L S E M V M S I N A I V I R V A F G D K C K - - - - - Q Q A Y F L H L V K E A M S Y V S S F S Y A D M Y P S L K F - L D T L T G L K S K L E G V H G K L D K V F D E I A Q R Q A A L A A E - - - - - Q A E E D - L I I D V L L K L K D - E - G N Q E - - - - - F P

L R D T I Q E M V N N V V S R A T L G D V S E - - - - - D R Q F I I D S T Y T M L K S F N S F N L F N Y Y P S L S F - I N V I S G K Q A Q W L K M H K E V D V L L K L R F H R S R P R G - - - - - K N D H E - D L V D V L I R I K E - T - G D I D - - - - - M A

F T E M T I E M V N N V I C K A T L G D S C K - - - - - D Q A K L E L L Y D V L K T L S A F N L A S Y Y P R L Q I - L N V I S G K K A K W L K M Q K Q L D G I M N D I L K E H R A E G R K - - - - - N N E Q E - D L V D V L L R V K E - T - G G L D - - - - - F N

F T E M T V E M V N N V I C K A T L G D S C K - - - - - D Q A T L I E V L Y D V L K T L S A F N L A S Y Y P G L Q F - L N V I L G K K A K W L K M Q K Q L D D I L E D V L K E H R S K G S N - - - - - K S D Q E - D L V D V L L R V K D - T - G G L D - - - - - F T

F T E M T V E M V N N V I C K A T L G D S C K - - - - - D Q A T L I E V L Y D V L K T L S A F N L A S Y Y P G L Q F - L N V I L G K K A K W L K M Q K Q L D D I L E D V L K E H R S K G R N - - - - - K S D Q E - D L V D V L L R V K D - T - G G L D - - - - - F T

Y T E M T I E M V N N V I C K A T L G D C C K - - - - - D Q A L L E L L Y D V L K T L S A F N L A S Y Y P R L Q F - L N V I S G K K A K W L K M Q K R L D D I M E D I L K E H R A K G R A K - - - - - N S D Q E - D L V D V L L R I K D - T - G G L D - - - - - I N

Y T E M T I E M V N N V I C K A T L G D C C K - - - - - D Q A L L E L L Y D V L K T L S A F N L A S Y Y P R L Q F - L N V I S G K K A K W L K M Q K L D D I M E D I L K E H R A K G R A K - - - - - N S D Q E - D L V D V L L R V K E - T - G G L D - - - - - I D

L T K S I F S L T F S I I S R T A F G K K C K - - - - - D Q E A F S V T L D K F A D S A G G F T I A D V F P S I K L - L H V V S G M R K L E K V H K K L D R L G N I I N E H K A R S A A K E T C E - - - - - A E V D D - D L V D V L L K V Q K - Q - G D I E - - - - - F P

F T Q R I I W F A S S M T C R S A F G Q V L K - - - - - G Q D I F A K K I R E V I G L A E G F D V V D I F P T Y K F - L H V L S G M K R K L N A H L K V D A I V E D V I N E H K K N L A A G K S N G - - - - - A L G G E - D L I D V L L R L M N - D - T S L Q - - - - - F P

F T E R L F L F T S S M T C R S A F G K V F K - - - - - E Q E T F I Q L I K E V I G L A G G F D V A D I F P S L K F - L H V L T G M E G K I M K A H H K V D A I V E D V I N E H K K N L A M G K T N G - - - - - A L G G E - D L I D V L L R L M N - D - G G L Q - - - - - F P

V T E R I F L F T S S M T C R S A F G Q V F K - - - - - E Q D K F I Q L I K E V I L L A G G F D V A D I F P S L K F - L H V L S G M K G K I M N A H H K V D A I V E N V I N E H K K N L A I G K T N G - - - - - A L G G E - D L I D V L L R L M N - D - G G L Q - - - - - F P

V S E K V S S I A N S I T C R S T I G R C K - - - - - Y Q H Q L E A T E N I A Y W A G A F M A D L F P S M L V - F P V L S G M K P A L Q K V R R E L D H I F D Y I I N E H K K E L A S R K Q Q G T K L E A E F - - - - - D L V D I L L R I N D - T - L Q L E - - - - - F P

M S E K F A E L S Y N I T S R A A I G K R - - - - - G D K E V I E M V E D I A Y W A A G F F I N D L F P S V K F - L S V L N G M K P A L K K I R R K I D H I F K E I I D E H K E K L A S R E K G V A V - D T Q D E - D L V D V L L R V N E - T - Q R L Q - - - - - F P

L S E S V A N L A H G V I S R A T T G K R - - - - - S D D E L A K I M E E I S Y W A G A F L I P D L F P S I K F - L P T L T G M R S G I Q K L R N A I N P F G S I E H R E K L A R K K E G K T I D N D A D E D L I D V L L R V N E - N - E R L E - - - - - F P

L S E S I F K I I A T I L S R A A F G K G I K - - - - - D Q R E F T E I V K E I L R L T G G F D V A D I F P S K K I - L H H L S G K R A K L T N I H N K L D S L I N N I V S F H P G S R T - - - - - S S S Q E - S L L D V L L R L K D - S - A - - - - - F P

L S E N I F K M I A T I L S R A A F G K G I K - - - - - D Q M K F T E I V K E I L R L T G G F D V A D I F P S K K L - L H H L S G K R A K L T N I H N K L D N L I N N I A E H P G N R T - - - - - S S S Q E - T L L D V L L R L K E - S - A - - - - - F P

L S E S I F T M I A T I L S R A A F G K G I K - - - - - D Q R E F T E I V K E I L R Q T G G F D V A D I F P S K K F - L H H L S G K R A R L T S I H K K L D N L I N N I V A E H V S T S - - - - - S K A N E - T L L D V L L R L K D - S - A - - - - - F P

L S E N I F K M I A T I L S R A A F G K G I K - - - - - D Q K E F T E I V K E I L R Q T G G F D V A D I F P S K K F - L H H L S G K R A R L T S I H K K L D N L I N N I V A E H P G N S - - - - - S K S N E - T L L D V L L R L K D - S - V - - - - - F P

L S E N I F K M I A T I L S R A A F G K G I K - - - - - D Q K E F T E I V K E I L R Q T G G F D V A D I F P S K K F - L H H L S G K R A R L T S I H K K L D N L I N N I V A E H P G N S - - - - - S K S N E - T L L D V L L R L K D - S - P - - - - - F P

L S E G I F K V I A T V L S R A A F G K G I K - - - - - D Q K Q F T E I V K E I L R E T G G F D V A D I F P S K K F - L H H L S G K R G R L T S I H N K L D S L I N N L V A E H T V S K S - - - - - S K V N E - T L L D V L L R L K N - S - E - - - - - F P

L S E N V F K I I A T I L S R A A F G K G I K - - - - - D Q K E F T E I V K E I L R Q T G G F D V A D I F P S K K F - L H H L S G K R A R L T S L R K K I D N L I D N L V A E H T V N T S - - - - - S K T N E - T L L D V L L R L K D - S - A - - - - - F P

L S E N I F K I I A T I L S R A A F G K G I K - - - - - D Q K E F T E I V K E I L R Q T G G F D V A D I F P S K K F - L H H L S G K R A R L T S I H Q K L D N L I N N L V A E H T V K T S - - - - - S K T N E - T L L D V L L R L K D - S - A - - - - - F P

L S E N I F K I I A T I L S R A A F G K G I R - - - - - D Q K E F T E I V K E I L R Q T G G F D V A D I F P S K K F - L H H L S G K R A R L T S I H T K L D N L I N N L V A E H T V K T S - - - - - S K T N E - T L L D V L L R L K D - S - A - - - - - F P

470 480 490 500 510 520 530 540 550 560 570 572

P E S F I P E R F X - N S S I D Y K G A D F E Y I P F G A G R R I C P G L P L G L A M V E L P L A N L Y H F D W K L P N - G M K P E D - - L D M T E K F G I T X Q K K K P L L V P X P Y S X L P E X Y X K
 P E F R P E R F L E E R K V E A N G N D F R Y L P F G V G R R S C P G I L A P I L G I T I G R V Q N F E L L P P G Q S K I D T - - A E K G G Q F S L H I L K H S T I I C K P R S F
 P L E F K P E R F L T D H E K L D Y L G N D S R Y M P F G S G R R M C A G V S L G E K M L Y S S L A A M I H A Y D W N L A D - - - G E E - - N D L I G L F G I M K K K K P L I L V P T P R P S N L Q H Y M K
 P L E F I P E R F L - - D G P W D Y S G K D F N Y F P F G S G R R I C A G I A M A E K M F L F S L A S L L H S F D W R L P E - - - G Q K - - L D L S E K F G I V L K K T V P L V L I P T A R L S N P E L Y Q
 P L L F D P E R F S - - D S K W D Y N G R D F D Y F P F G S G R R I C A G I S M A K I M V H Y S L A S L L H S F D W S L P V - - - A I K - - L N M D E K Y G I V L R K A V P L V A L P K P R L L Y P N L Y E
 A L S F R P E R F L - - E S S T E Y K G Q N Y Q F I P F G A G R R M C P G L P L G H R V L P L I L G S L L H H F D W K L C E S V S G E I N - - I D M R E T V G I S A R K V V P L R A V P K R M A A
 T L S F K P E R F L - - D S N I N Y K G Q C Y E F L P F G A G R R M C P G V P L A N R M V H L I L G S L L H H F E W E L C D - - D E K I - - L D M R E T M G E T S N K L E L L Q A I P K P K S T
 A L S F K P D R F L - - N L S I N Y K G Q N F E F I P F G A G R R I C P G I P L A H R M L P L L L G T L L H H F D W K L C G - - G D T N - - I D M M E T M G L G A R K Q E P L M A V P T R K N L P
 P T H F T P E R F L - - S S E I D Y K G R Y F S F L P F G S G R R I C P G I R L A E R V M S L M L M S L V A K F D W K L P N - N M S P K E - - L D M D D T F G V T S Q K A T P L L V P T P R N N
 P L S F Q P D R F I - - N S E I D V N G H D Y E L P F G A G R R I C P G I P L A M R M V P A M L G S L I N C F E W R L E G - G I A P E E - - L N M E D K F G L T L A K L H P L R V V A T S V V P
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G I P L A I R M V H L M L G S L I H G F R W K V D D D G M G S P E T A M D M D E K F G I T L Q K A K P L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V D D D G M G S P E T A M D M D E K F G I T L Q K A K S L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V D D D G M G S P E T A M D M D E K F G I T L Q K A K P L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V D D D G M G S P E T A M D M D E K F G I T L Q K A K P L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V A D D G M G S P E T A M D M D E K F G I T L Q K A K S L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V A D D G M G S P E T A M D M D E K F G I T L Q K A K S L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V A D D G M G S P E T A M D M D E K F G I T L Q K A K S L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V D D D G M G S P E T A M D M D E K F G I T L Q K A K P L C A V P I R G
 P E S F L P E R F L - - G S D V D V K G R S F E L I P F G G G R R I C P G L P L A I R M V H L M L G S L I H G F R W K V D D D G M G S P E T A M D M D E K F G I T L Q K A K P L C A V P I R G
 A H E F F P E R F M - - S S N V D L Q G Q D F Q L P F G S G R R G C P G M R L G L T T R L V L A Q L I H C F D L E P K - G T V A T D - - L D M S E K F G L A M P R A Q H L L A F P T Y R L E S
 P E F Q P E R F L - - N S S I D F K G Q D F Q L P F G A G R R A C P G I A F A M A T N E F V L A N L L H K F D W K F P D - G R N G E D - - L D M S E R P S A A V Q R K V P L L A M A T S C C C
 P D E F R P E R F L - - N S T I D Y R G Q D F Q L P F G A G R R S C P G I S F A M V T T E L V L A N L L H N F D W E L P N - G T K G K D - - L D M T E T T G T V I H K K E P L L A V A I P Y S I
 A D E F K P E R F L - - D T N I D Y K G L N F E L L P F G A G R R G C P G I Q F A M S V N K L A L A N L L Y K F D W L P N - G L R L E Q - - L D M T D S T G T V R R K Y P L L V I P T A R F
 P G E F I P E R F L - - N N S V D Y K G L H F E F I P F G A G R R G C P G I Q Y A M A I N E L A L A T L V H I F D F A L P D - G K R F E D - - L D M A S E T G M T V H K K S P L L V I A T P R I
 P E K F I P E R F L - - N N P I D Y K G L H F E F I P F G A G R R G C P G I Q Y A M A I N E L A L A N L V H I F D F A L P D - G R R L E D - - L D M T S E T G M T L H K K S P L L V I A T S R V
 P E E F K P E R F L - - D S S I D F R G Q H F E L L P F G A G R R G C P G T N F G V L I E L A L A N M L F S F N W R L P D - G M N A K D - - I D M E G V G I T V H K K T P F C L Y A S P Y V Y S
 A E E F Y P E R F L - - D S E I D F K G Q D F E F I P F G A G R R I C A G M Y M G T T T L K L I L S N L L Y S F D W E L P A - G M V K E D - - V D T Q V L P G I S M H M K N P L R L V A K K Y N
 P N E F Y P E R F E - - N F N I D F L G N H C E M I P F G A G R R S C P G M K S A T S T I E F T L V N L L Y W F D W E V P S - G M N N Q D - - L D M E D G F L V I Q K K S P L F L I P I K H I
 P L E F Y P E R F E - - N N D V D Y K G D Y T H Y I P F G A G R R M C P G M T M G I A T V D Y T L A T L L N F D W D L P A - G M K P E D - - I K M D E K V G L T I H K V K P L Y L V P T K Y Q P
 P E E F Y P E R F E - - D S E S D F K G Q N Y E F I P F G A G R R M C P G V I M G L A S V E S I L A S L L H C F D W Q L P R - G M N P E D - - I S M E E V G L T I N K K F P L Q L V P I K H E I Q T E
 Q E E F Y P E R F E - - D S E S D F K G Q N Y E F I P F G A G R R M C P A M T M G L A S V E S I L A N M L H C F D W Q L P S - G M K P E D - - I N M E E V G L T V N K K F P L E L V P I K H E I Q T E
 A E S F K P E R F E - - G I S V D F K G S N F E F M P F G A G R R I C P G M T F G I S S V E V A L A H L L F H F D W Q L P Q - G M K I E D - - L D M M E V S G M S A T R R S P L L V L A K L I I P L P
 P D S F I P E R F E - - N N S I G Y S G A D F E F I P F G A G R R I C P G M N F G M G T V E Y V V A N L L L H Y D W K L P D - G M K P H D - - I D M R E I T G S T L P I H P L K I M P I S L S K
 P E S F I P E R F E - - N S P V S Y M G A D F E F I P F G A G R R I C P G L T F G L S M V E Y P L A N F L Y H F D W K L P N - G M K P H E - - L D I T E V T G S T S L K H H L K I V A I P K S L A K
 P E S F I P E R F E - - N C P I N Y M G A D F E F I P F G A G R R I C P G L T F G L S M V E Y P L A N F L Y H F D W K L P N - G L K P H E - - L D I T E I T G S T S L K H Q L K I V P M I P K S I A K
 A E S F I P E R F E - - N C P I N Y M G A D F E F I P F G A G R R I C P G L T F G L S M V E Y P L A N F L Y H F D W K L P N - G L K P H E - - L D I T E I T G S T S L K H Q L K I V P I L K S
 P D S F I P E R F E - - N S S I N F M G A D F Q Y I P F G A G R R I C P G L T F G L S M V E Y P L A H F L Y H F D W K L P Y - G M K P H E - - L D I T E I T T S T S L K H H L K I V P F P K S S L A K
 P E S F I P E R F K - - N C P I N F M G A D F Q Y I P F G A G R R I C P G L T F G L S M V E Y P L A H F L Y H F D W K L P N - G M K P H E - - L D I T E I T T S T S L K H H L K I V P F P K S S L A K
 A E S F N P E R F L - - D S S I D Y Q G T N F E Y I P F G A G R R M C P G I L F G M A N V E L A L A Q L L Y H F D W K L P N - G A R H E E - - L D M T E G F R T S T K R K Q D L Y L I P I T Y R P L P V E
 A E S F K P E R F E - - Q C S V D F F G N N F E F L P F G G G R R I C P G M S F G L A N L Y L P L A Q L L Y H F D W K L P T - G I M P R D - - L D L T E L S G I T I A R K G G L Y L N A T P Y Q P S R E
 A D N F K P E R F E - - Q C S V D F I G N N F E Y L P F G G G R R I C P G I S F G L A N Y L P L A Q L L Y H F D W K L P T - G M E P K D - - L D L T E L V G V T A A R K S D L M L V A T P Y Q P S R E
 A E T F M P E R F E - - Q C S K D F V G N N F E Y L P F G G G R R I C P G I S F G L A N A Y L P L A Q L L Y H F D W K L P A - G I E P S D - - L D L T E L V G V T A A R K S D L Y L V A T P Y Q P P Q K
 A N S F V P E R F D - - K S S V D Y I G A N Y E Y I P F G A G R R M C A G I S F G I A S V E L P L A K M L Y H F D W T L P N - G M K P E D - - L D M D E T F G A T T K R K N S L F L N A N P Y I S T L P N
 A E T F I P E R F E - - N S S L D F S G T N F D Y L P F G A G R R M C P G I N F G I A G V E L P L A Q L L Y H F N W K L P N - D T K P D D - - L N M E S F G A T N K R K Q N L V L P A L P R S L
 A E S F K P E R F E - - N N S I D F G L D Y E Y L P F G S G R R M C P G M N F G I A G V E L P L T Q L L Y H F D W K L P N - N M K P G D - - L D L E D A F G S T T K R K N H L V L I P T A E Y A A Q K A
 A E T F M P E R F E - - N S P I N I M G S E Y E Y L P F G A G R R M C P G A A L G L A N V E L P L A H I L Y Y F N W K L P N - G A R L D E - - L D M S E C F G A T V Q R K S E L L V P T A Y K T A N N S A
 A E T F M P E R F E - - N S P I T V M G S E Y E Y L P F G A G R R M C P G A A L G L A N V E L P L A H I L Y Y F N W K L P N - G K T F E D - - L D M T E S F G A T V Q R K T E L L V P T D F Q T T A S T
 A E A F I P E R F E - - N N P N N I M G A D Y E Y L P F G A G R R M C P G A A L G L A N V Q L P L A N I L Y H F N W K L P N - G A S H D Q - - L D M T E S F G A T V Q R K T E L L V P S F
 A E S F I P E R F E - - N S P I T V M G A E Y E Y L P F G A G R R M C P G A A L G L A N V Q L P L A N I L Y H F N W K L P N - G A S H D Q - - L D M T E S F G A T V Q R K T H L V L P S F
 A E S F I P E R F E - - N S P T N V M G A E Y E Y L P F G A G R R M C P G A A L G L A N V L P L A T I L Y H F N W K L P N - G A S H Q - - L D M T E S F G A T V Q R K T H L V L P S F
 A E S F N P E R F E - - N S N T T I M G A D Y E Y L P F G A G R R M C P G S A L G L A N V Q L P L A N I L Y Y F K W K L P N - G A S H D Q - - L D M T E S F G A T V Q R K T E L M L V P S F
 A E A F I P E R F E - - N S S A T V M G A E Y E Y L P F G A G R R M C P G A A L G L A N V Q L P L A N I L Y H F N W K L P N - G V S Y D Q - - I D M T E S S G A T M Q R K T E L L V P S F
 A E T F I P E R F E - - N S S T T V M G A E Y E Y L P F G A G R R M C P G A A L G L A N V Q L P L A N I L Y H F N W K L P N - G A S Y D Q - - I D M T E S F G A T V Q R K T E L L V P S F
 A E T F I P E R F E - - N S S T T V M G A E Y E Y L P F G A G R R M C P G A A L G L A N V Q L P L A N I L Y H F N W K L P N - G A S Y D Q - - I D M T E S F G A T V Q R K T E L L V P S F