Codon bias coevolves with longevity

Supplementary material

Contents

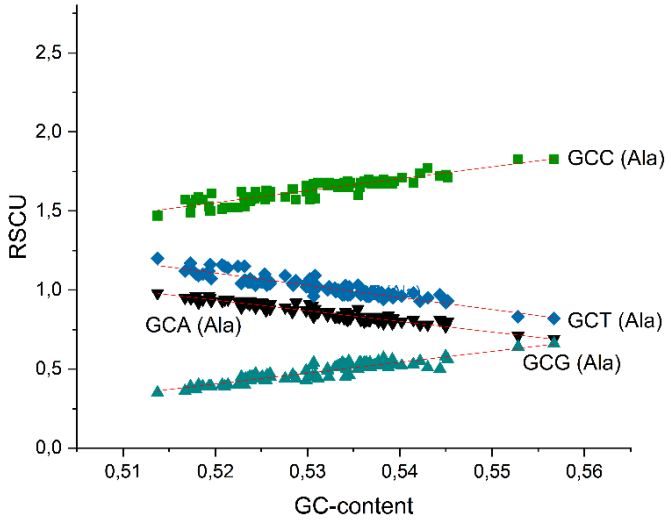
Impact of GC content of coding genomes on codon bias of mammalian species

The file presents the plots reflecting the impact of GC content of coding genomes on codon bias of mammalian species. The parameters of the regression analyses of these plots are presented in Supplementary file 2.

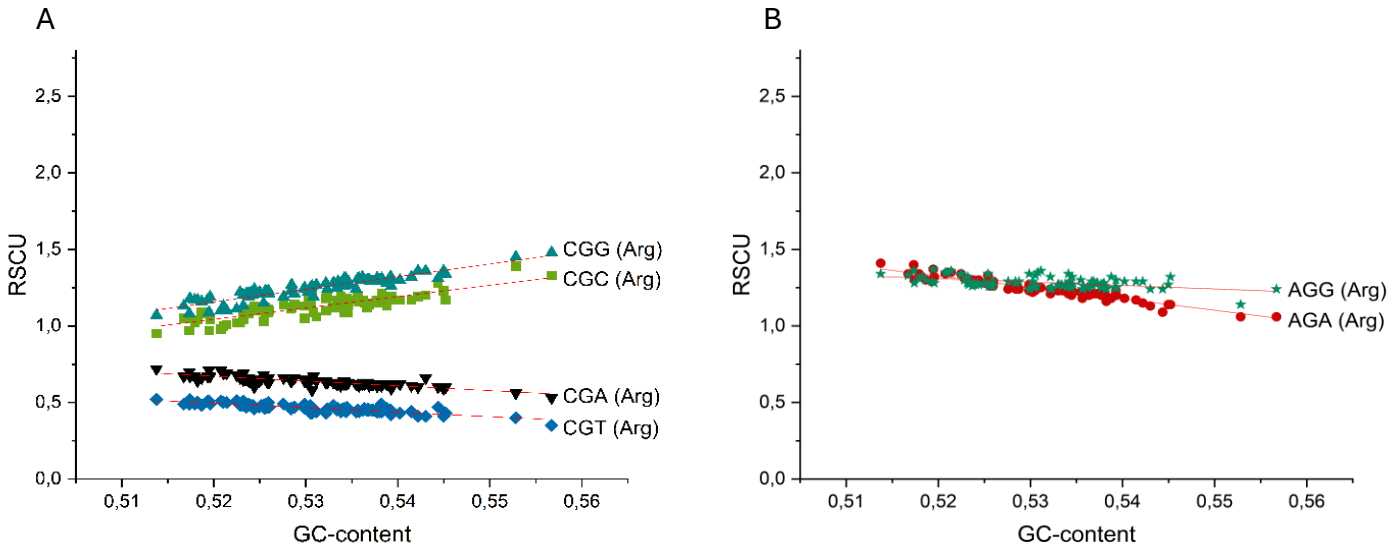
The plots are presented in alphabetical order of the names of the amino acids; data for amino acids Met and Trp that are encoded by a single codon are not shown.

We also present the data for the three stop codons at the end of the list of the 18 amino acids encoded by more than one synonymous codon.

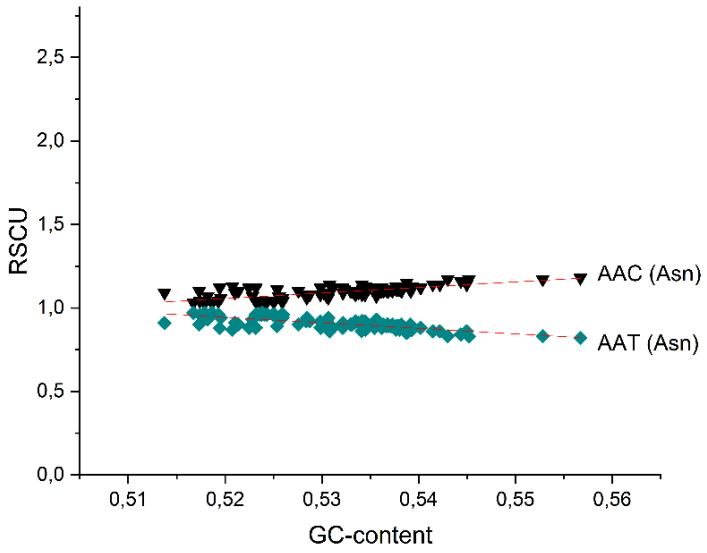
In the case of the 18 amino acids and the termination codons the figures present the plots reflecting the impact of the GC content of the coding genome of mammalian species on the relative synonymous codon usage (RSCU) of the given amino acid or termination codons. In these analyses we have plotted the RSCU values as a function of the GC-content of the coding genomes of the 96 mammalian species included in the present analysis.



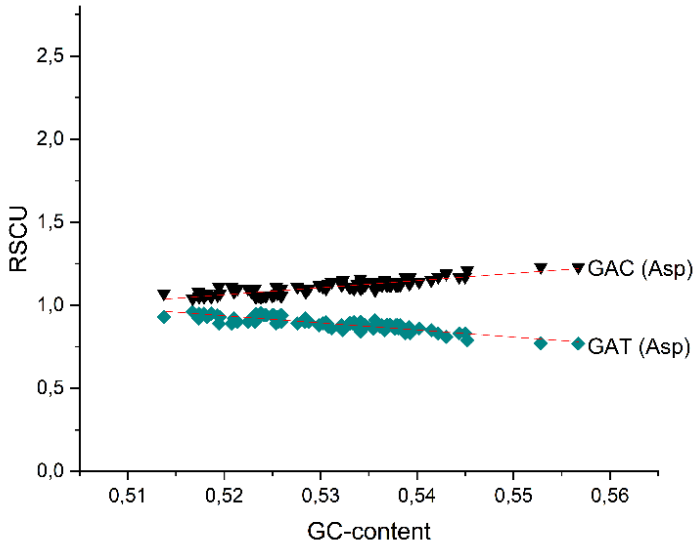
Supplementary figure 1.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the four **alanine** codons.



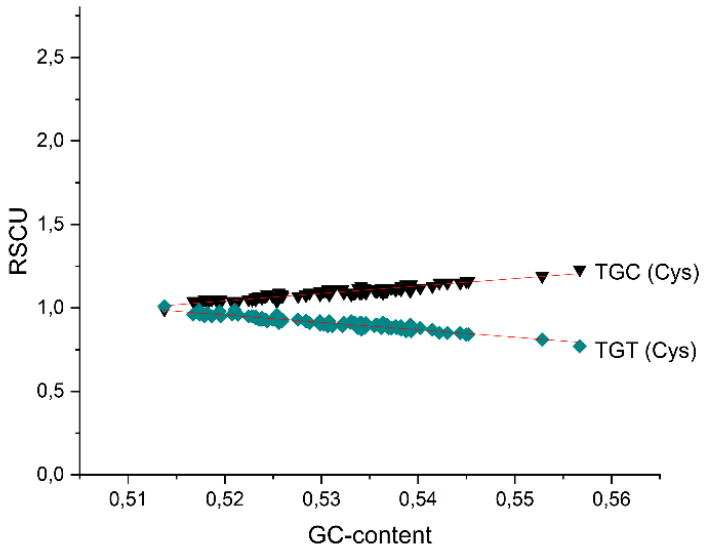
Supplementary figure 2.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the six **arginine** codons.



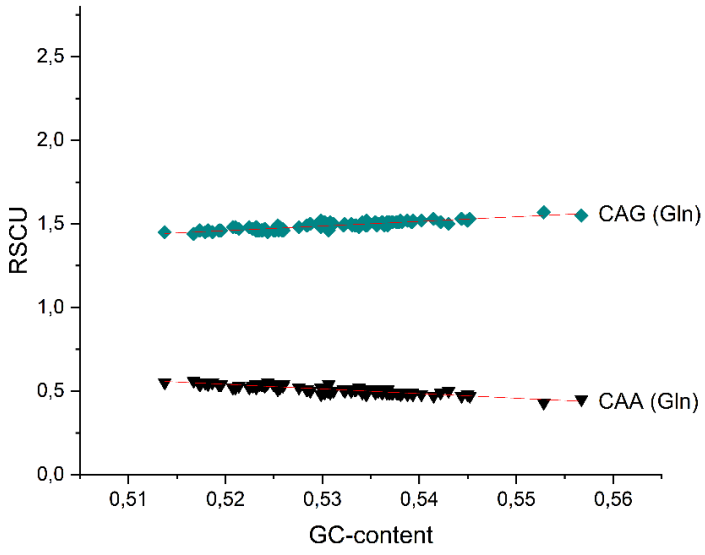
Supplementary figure 3.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **asparagine** codons.



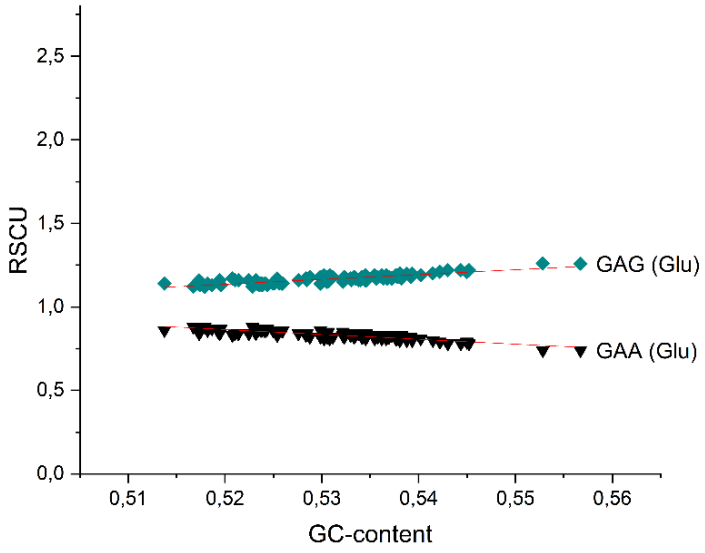
Supplementary figure 4.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **aspartic acid** codons.



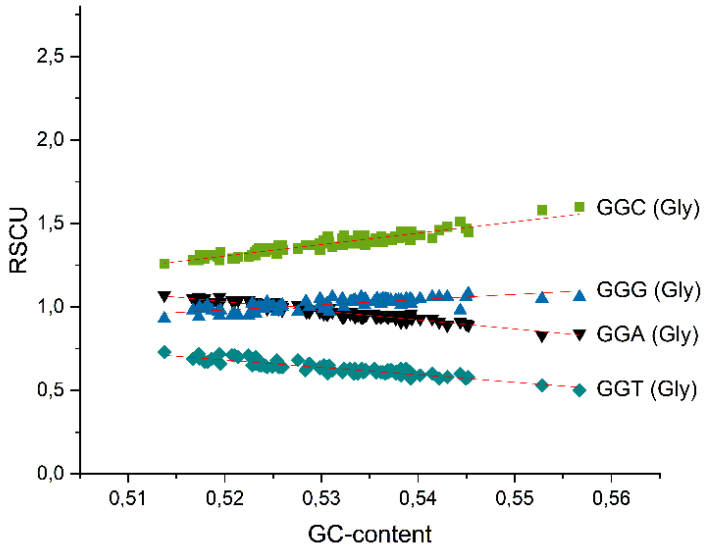
Supplementary figure 5.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **cysteine** codons.



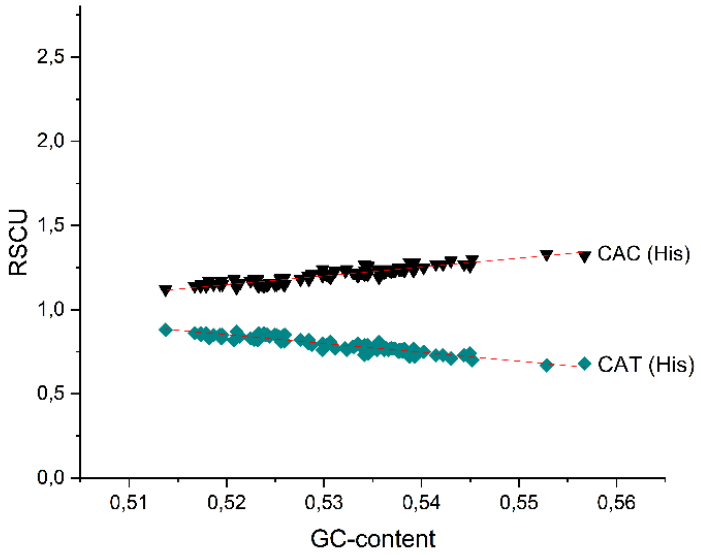
Supplementary figure 6.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **glutamine** codons.



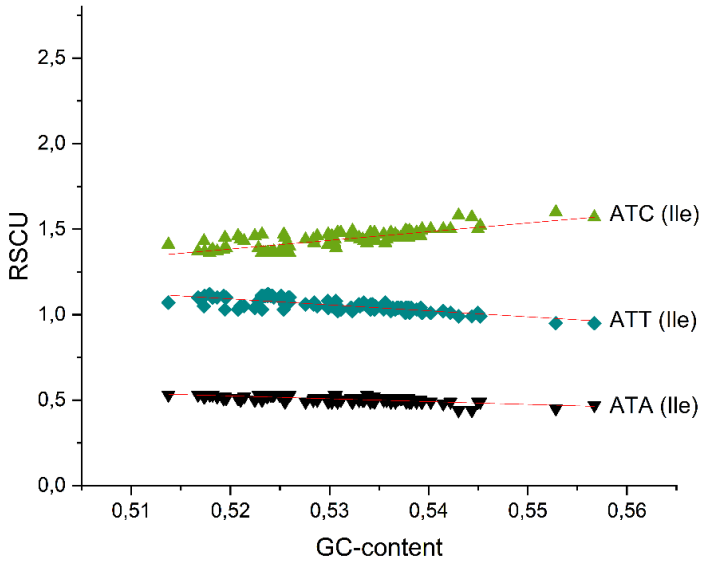
Supplementary figure 7.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **glutamic acid** codons.



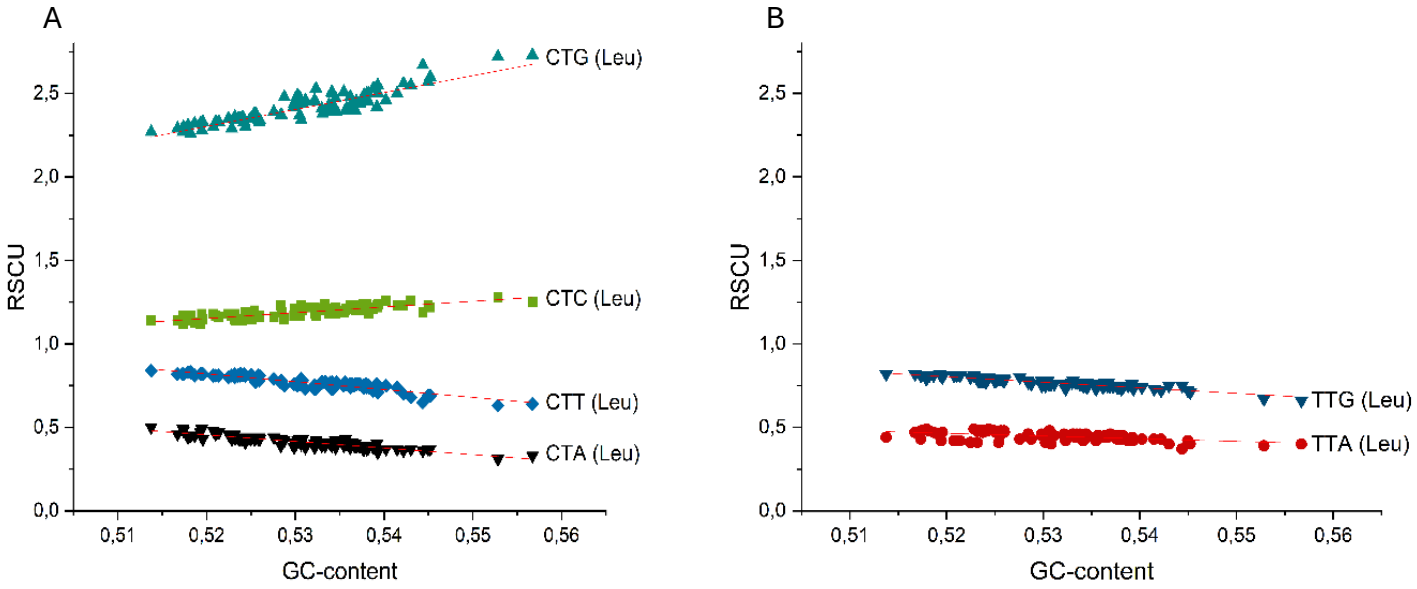
Supplementary figure 8.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the four **glycine** codons.



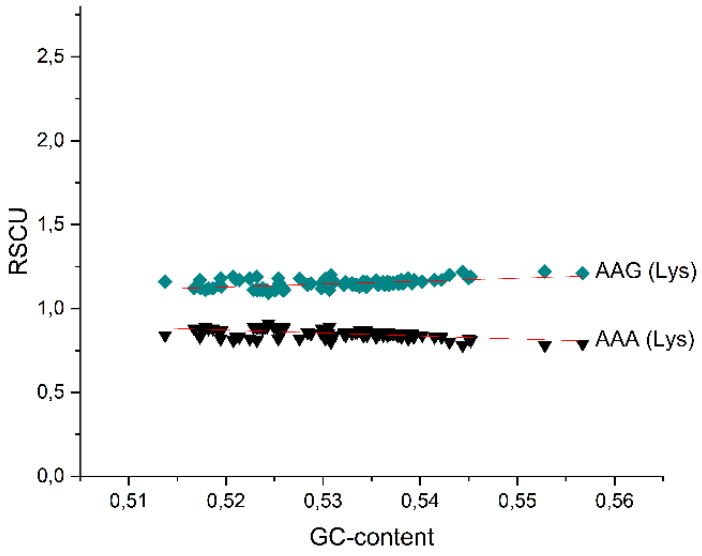
Supplementary figure 9.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **histidine** codons.



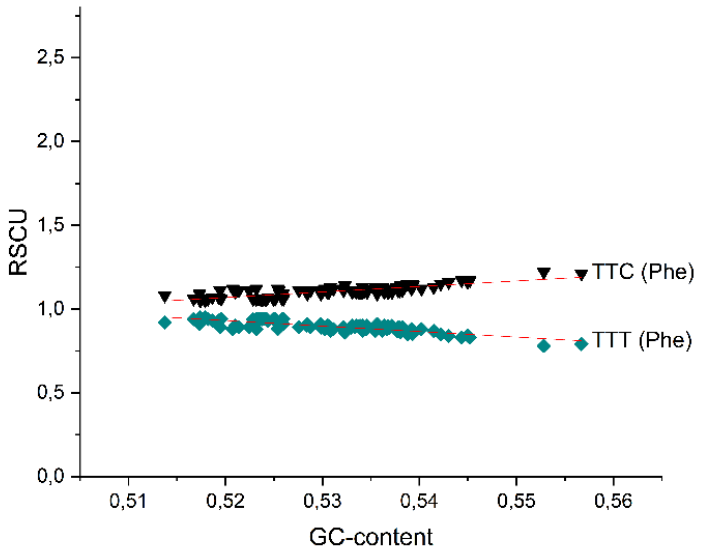
Supplementary figure 10.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the three **isoleucine** codons.



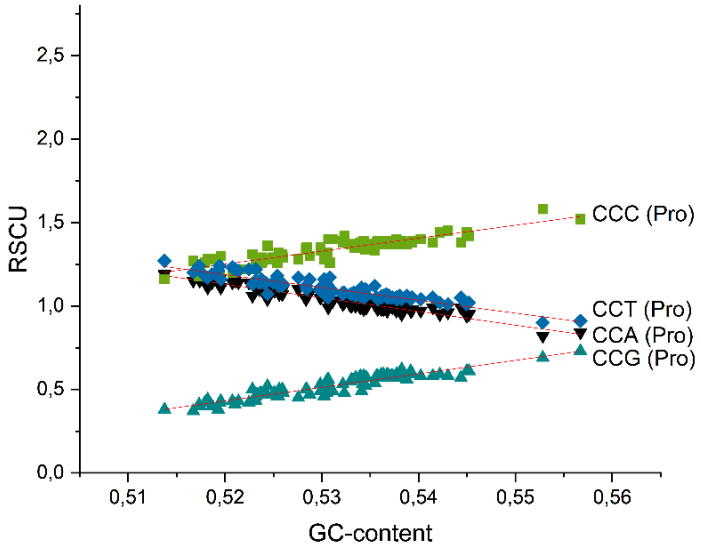
Supplementary figure 11.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the six **leucine** codons.



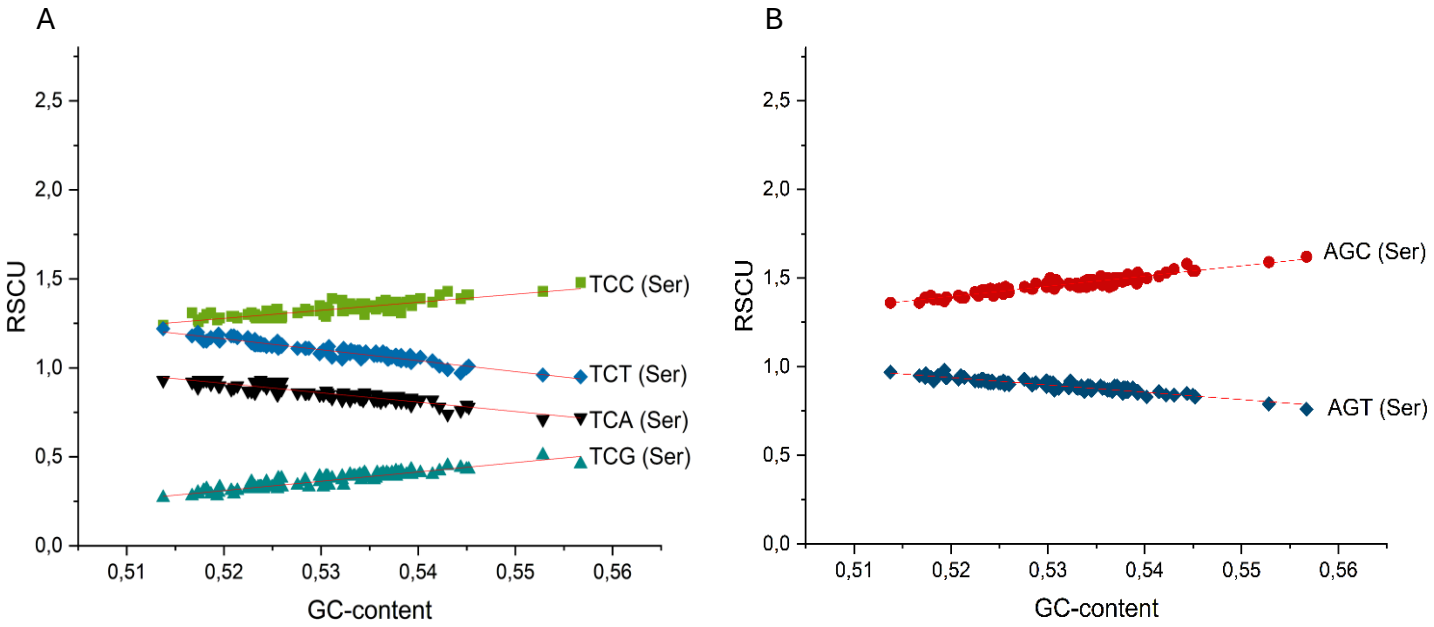
Supplementary figure 12.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **lysine** codons.



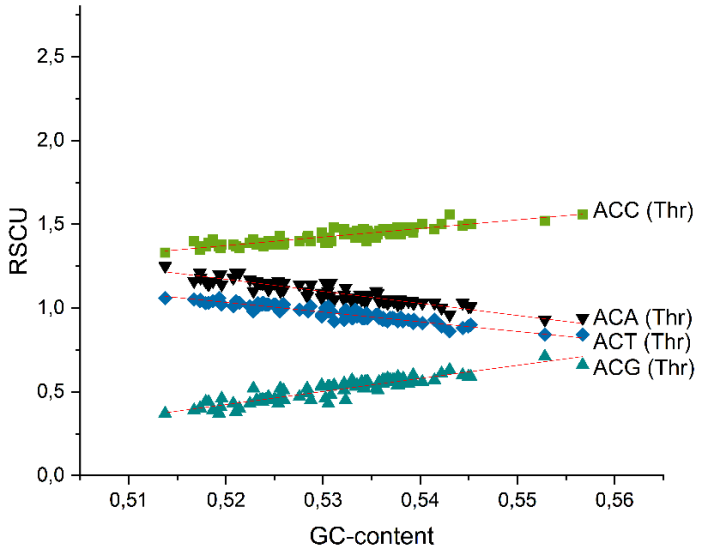
Supplementary figure 13.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **phenylalanine** codons.



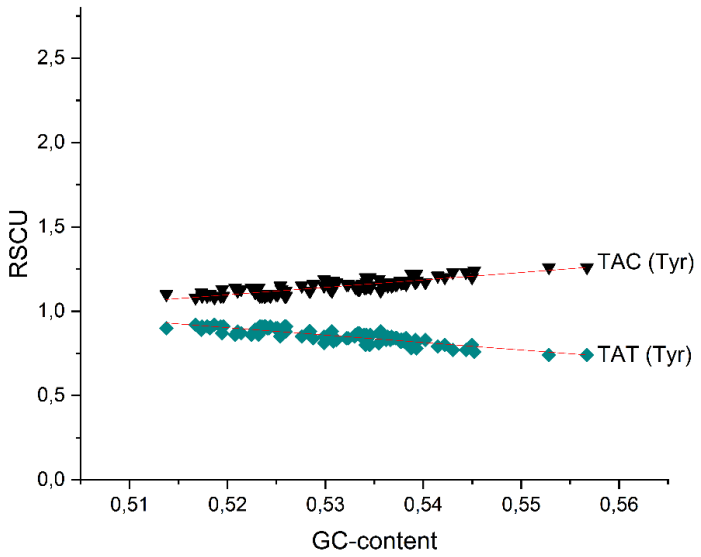
Supplementary figure 14.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the four **proline** codons.



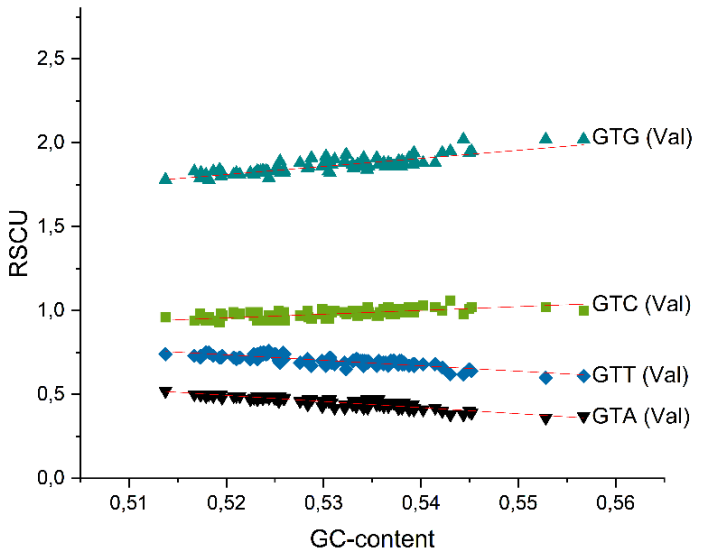
Supplementary figure 15.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the six **serine** codons.



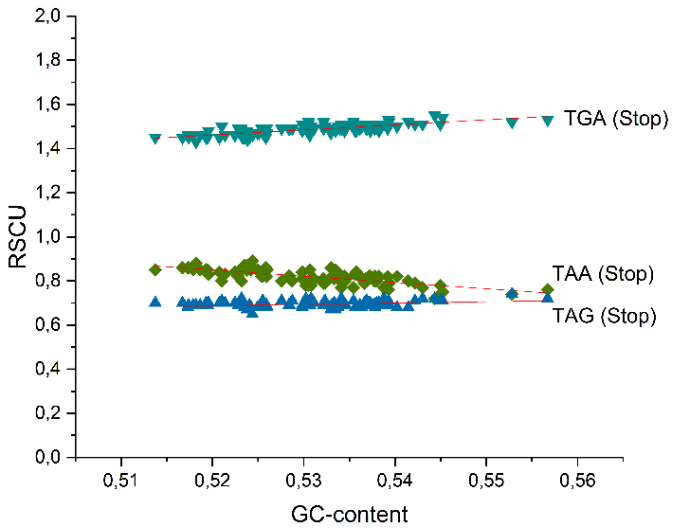
Supplementary figure 16.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the four **threonine** codons.



Supplementary figure 17.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the two **tyrosine** codons.



Supplementary figure 18.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the four **valine** codons.



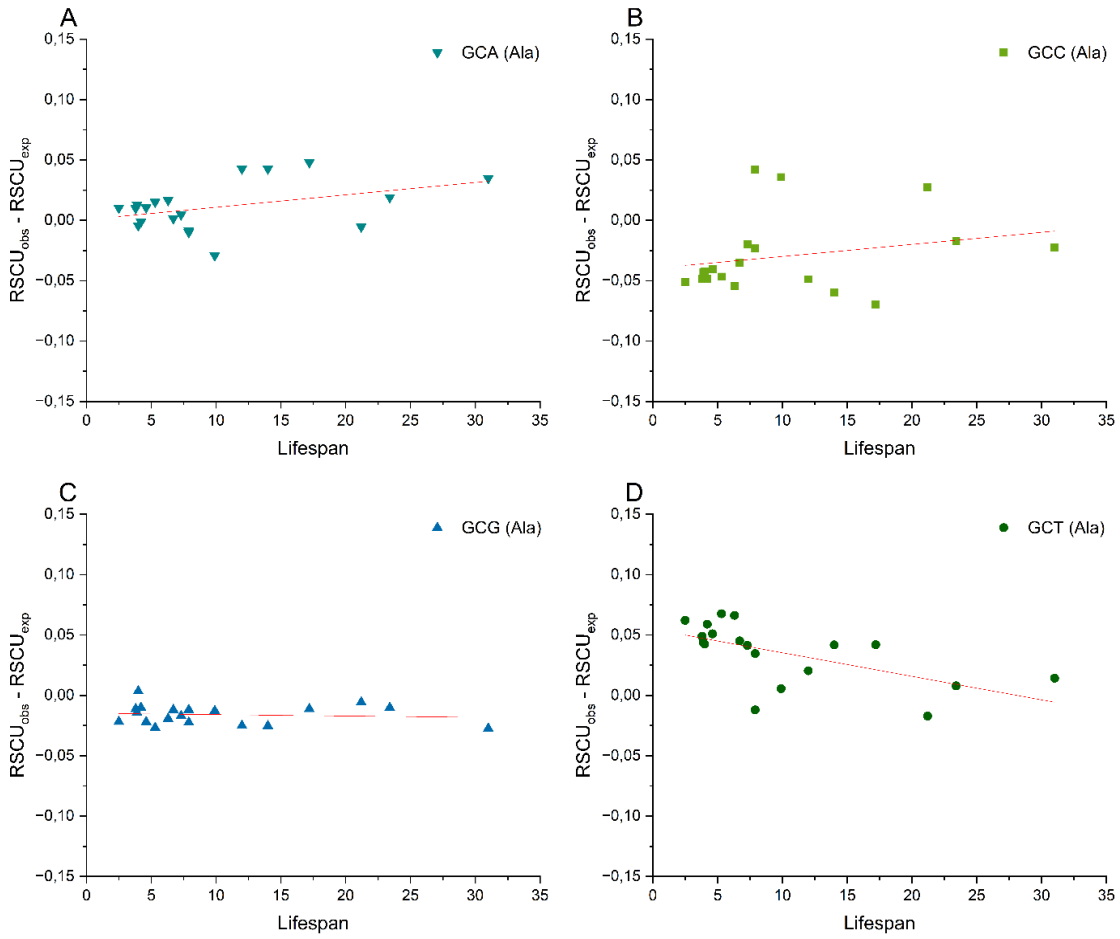
Supplementary figure 19.a. Impact of the GC content of coding genomes of mammalian species on their relative synonymous codon usage (RSCU) of the three **stop** codons.

Changes in codon usage and evolution of longevity in mammalian species

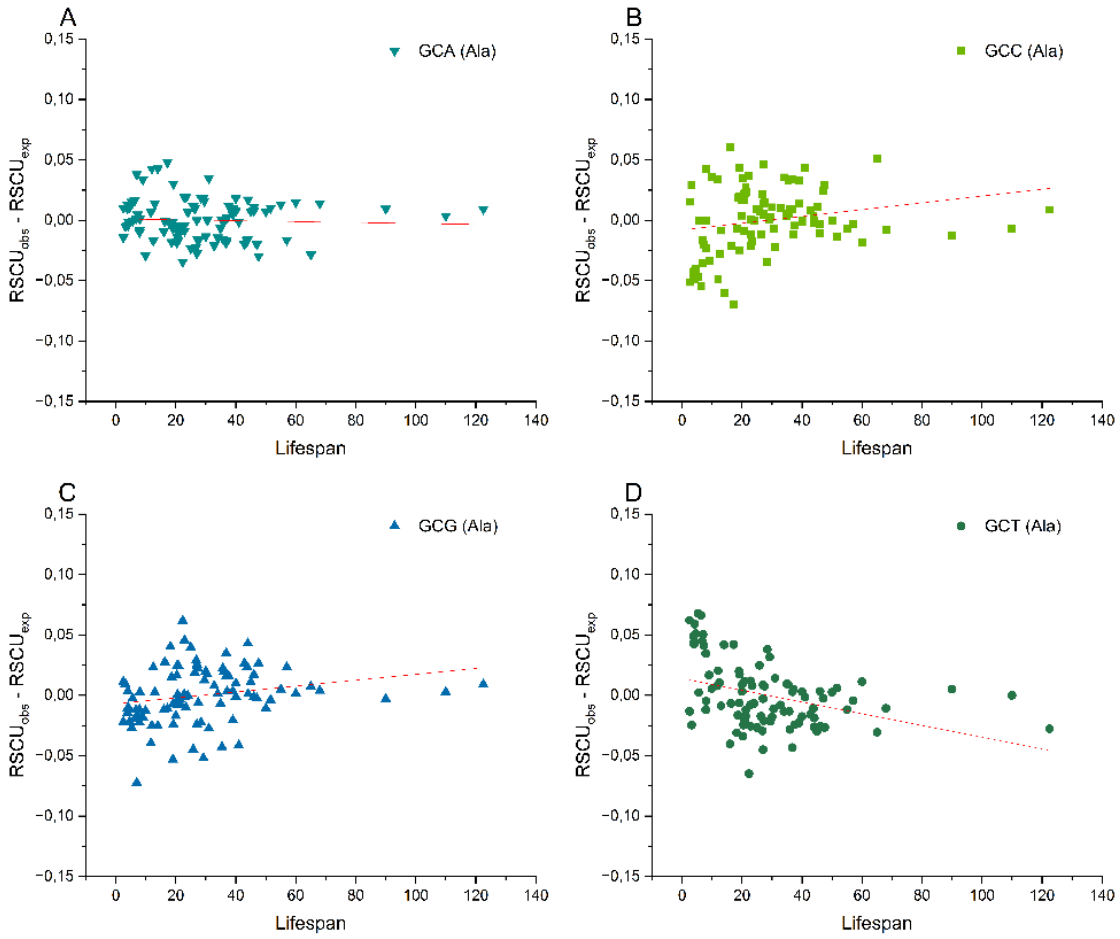
The file presents the plots reflecting changes in codon usage as a function of the lifespan of mammalian species. Note that in these analyses we have subtracted the RSCU values expected at the given GC content ($RSCU_{exp}$) from the actual RSCU values ($RSCU_{obs}$) and plotted these deviations as a function of the known lifespan (years) of the species. The parameters of the regression analyses of these plots are presented in Supplementary file 2.

The plots are presented in alphabetical order of the names of the amino acids; data for amino acids Met and Trp that are encoded by a single codon are not shown. We also present the data for the three stop codons at the end of the list of the 18 amino acids encoded by more than one synonymous codon.

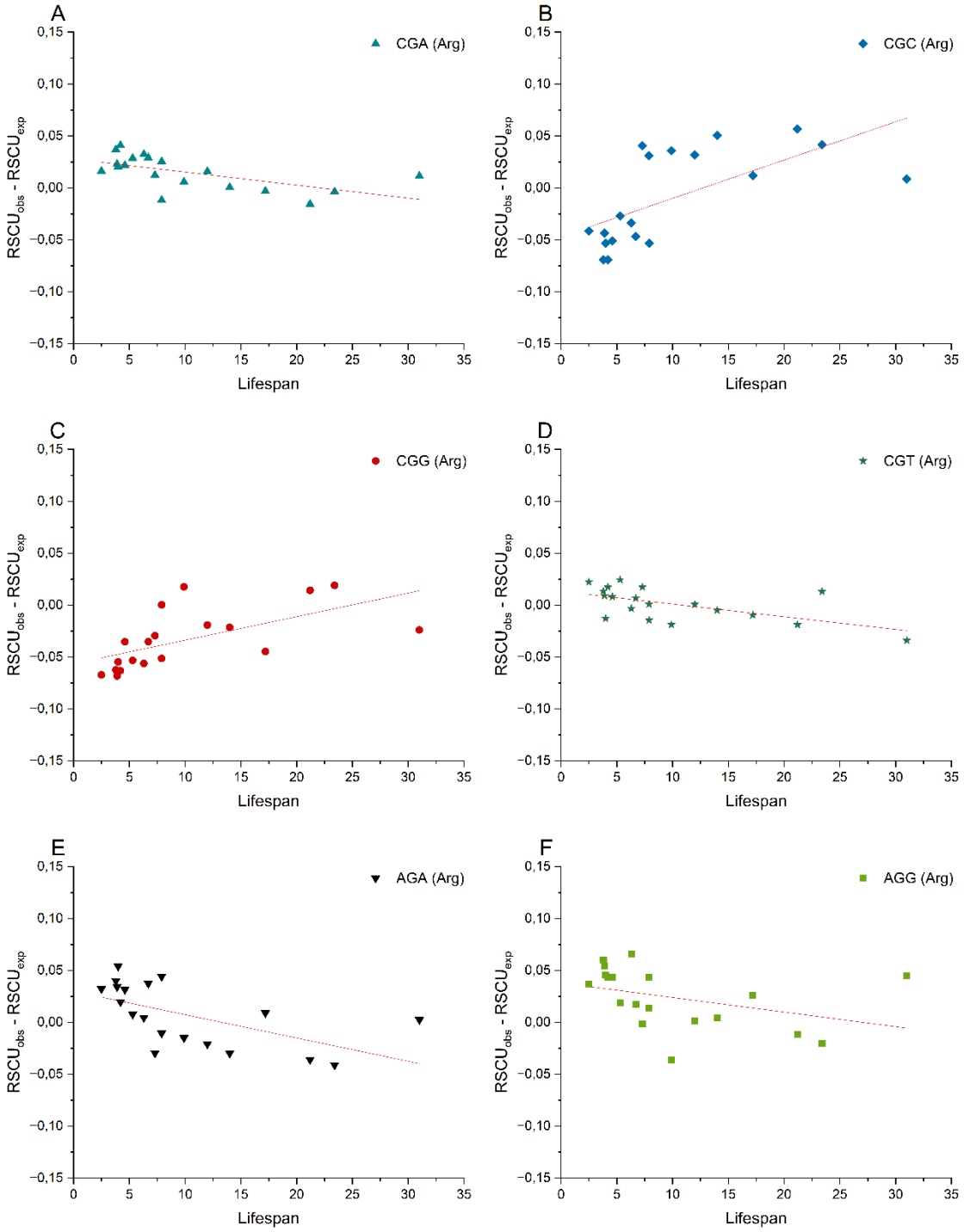
In the case of the 18 amino acids and the termination codons the first figures (**Supplementary figures x.a**) present the plots reflecting changes in codon usage as a function of the lifespan of 19 rodent species. The second figures (**Supplementary figures x.b**) present the plots reflecting changes in codon usage as a function of the lifespan of the 96 mammalian species included in the present analysis.



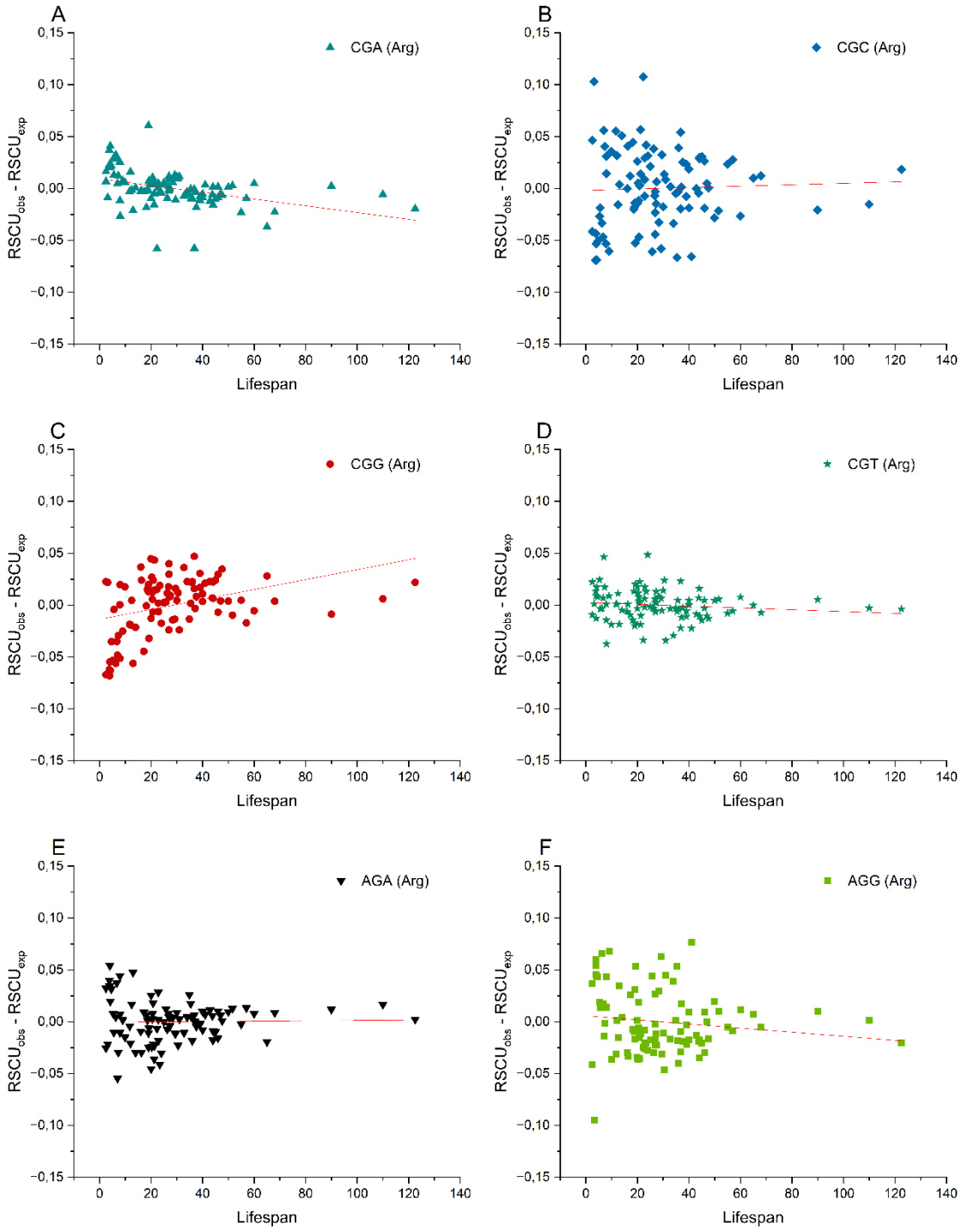
Supplementary figure 1.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **alanine**, plotted against maximum lifespan (years) of 19 **rodent** species.



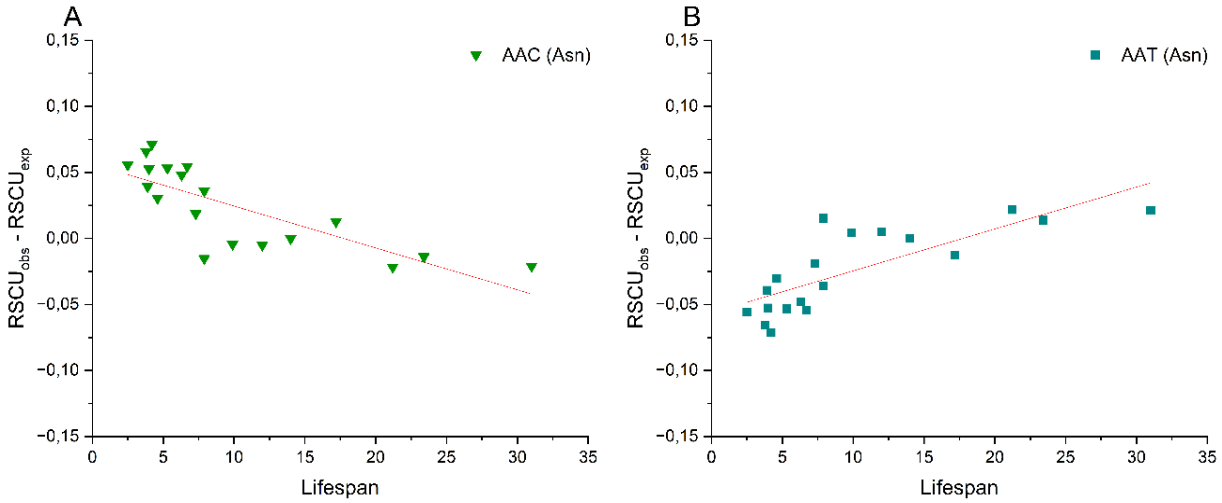
Supplementary figure 1.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **alanine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



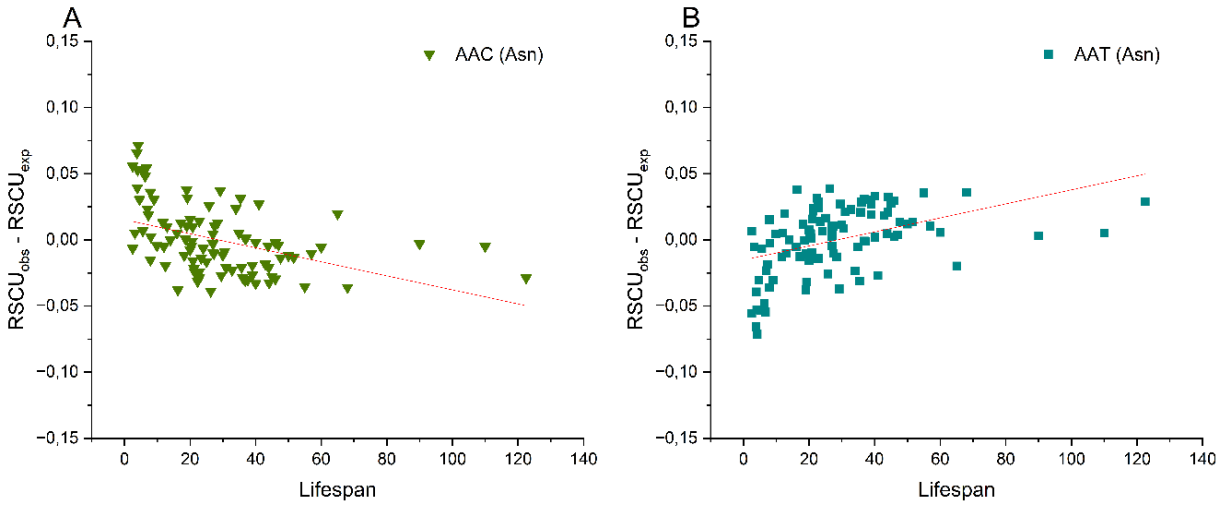
Supplementary figure 2.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **arginine**, plotted against maximum lifespan (years) of 19 **rodent** species.



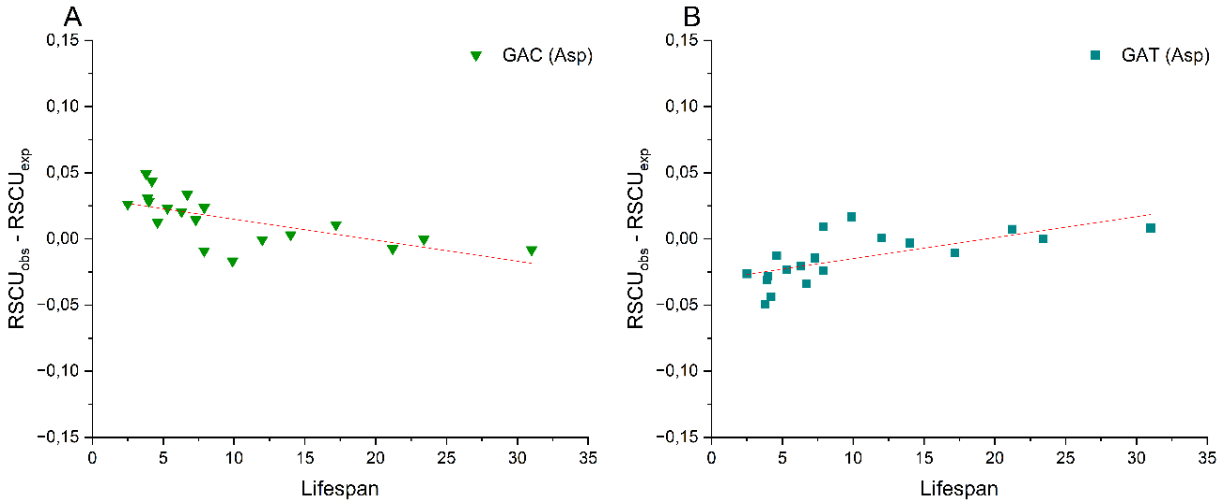
Supplementary figure 2.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **arginine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



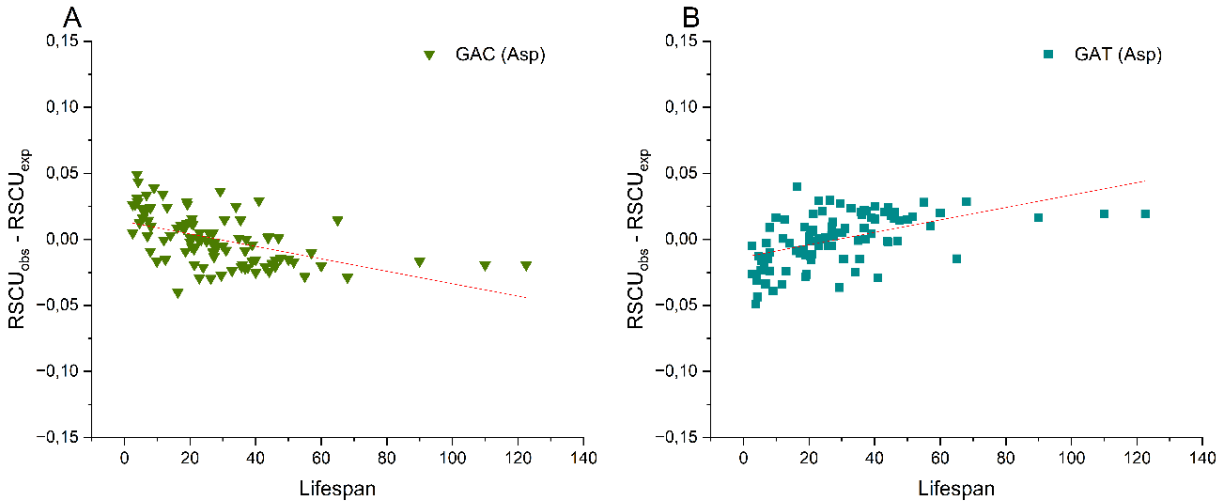
Supplementary figure 3.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **asparagine**, plotted against maximum lifespan (years) of 19 **rodent** species.



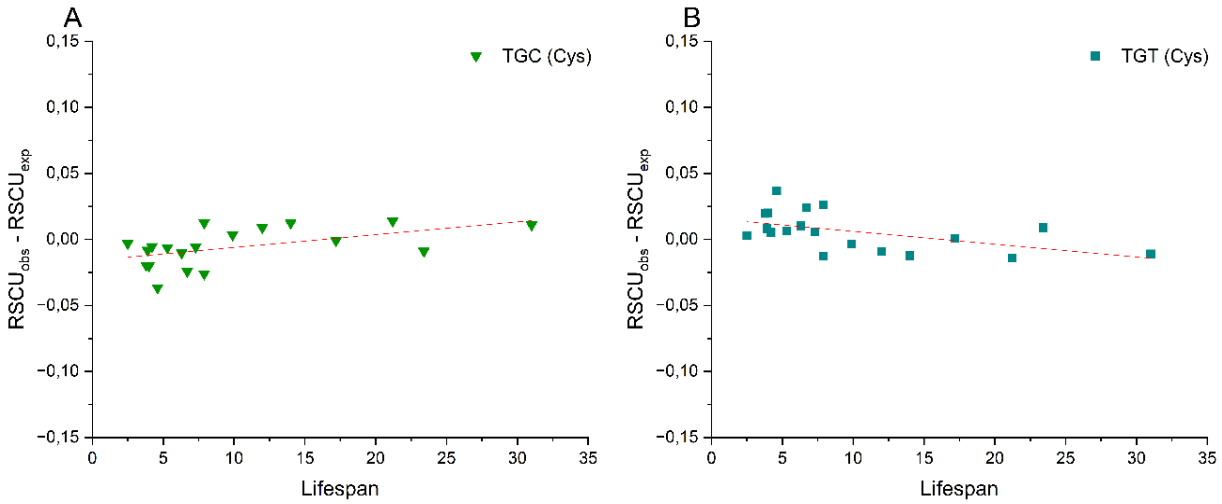
Supplementary figure 3.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **asparagine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



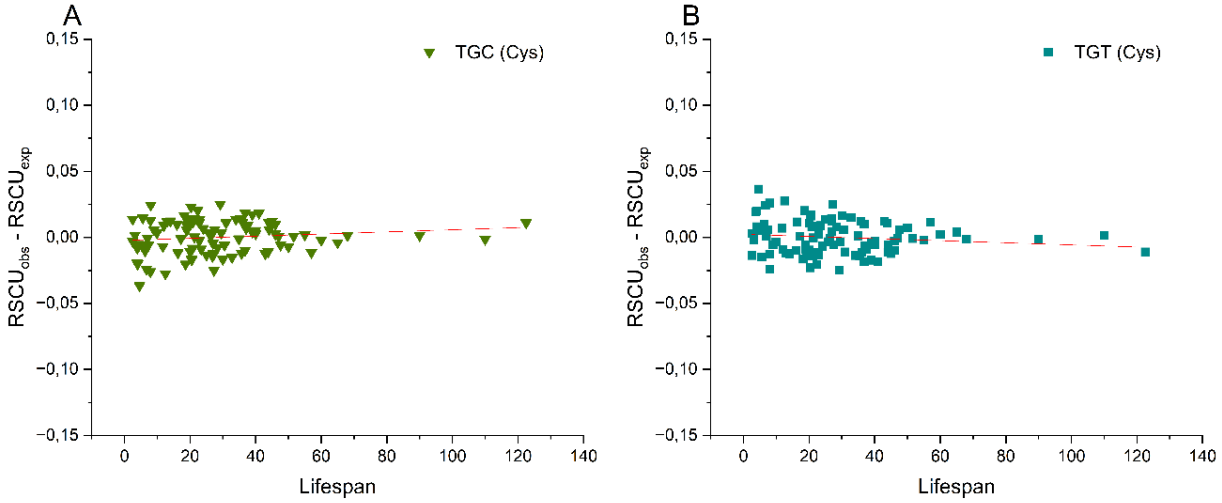
Supplementary figure 4.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **aspartic acid**, plotted against maximum lifespan (years) of 19 **rodent** species.



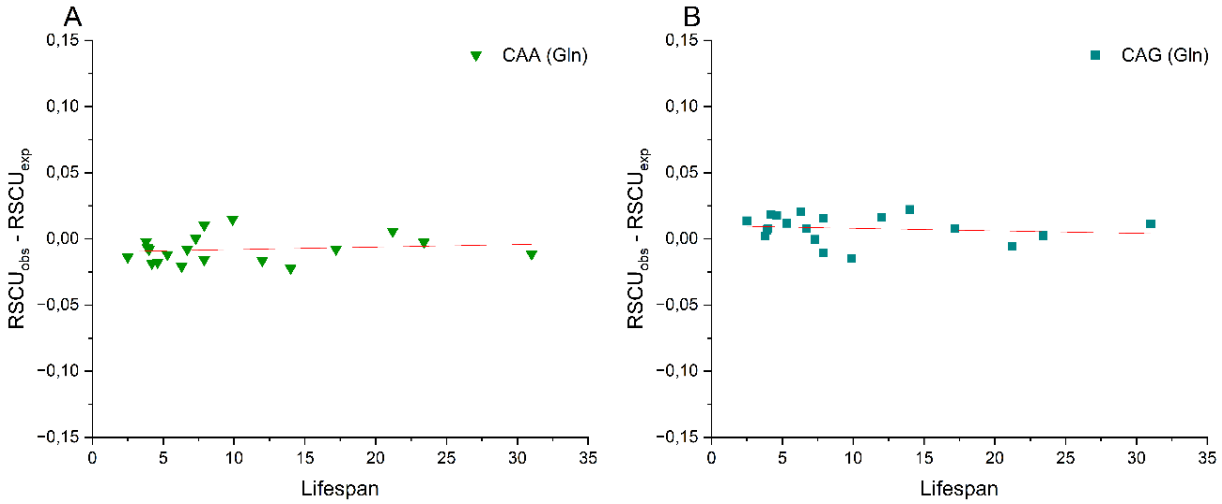
Supplementary figure 4.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **aspartic acid**, plotted against maximum lifespan (years) of 96 **mammalian** species.



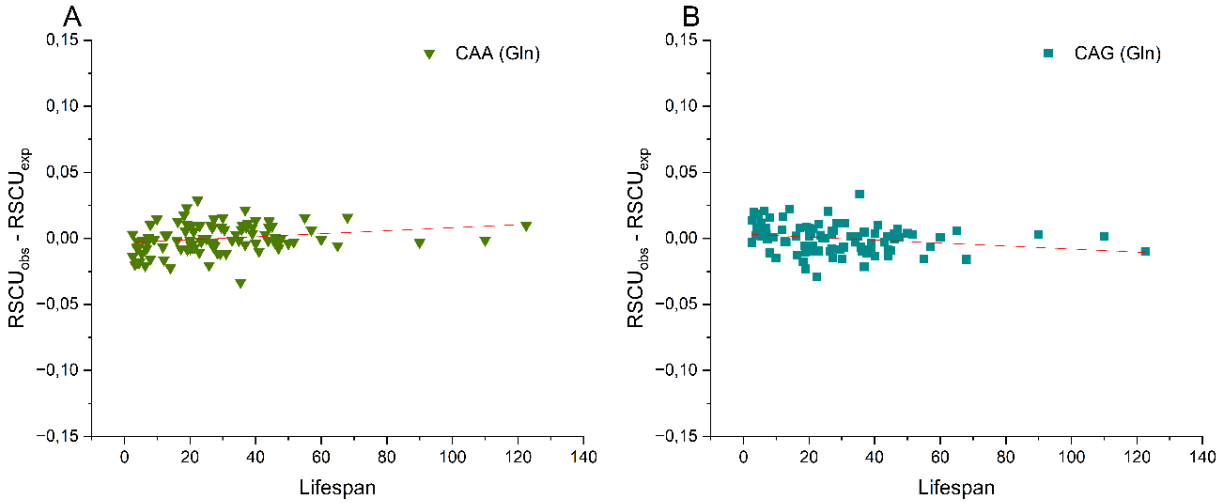
Supplementary figure 5.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **cysteine**, plotted against maximum lifespan (years) of 19 **rodent** species.



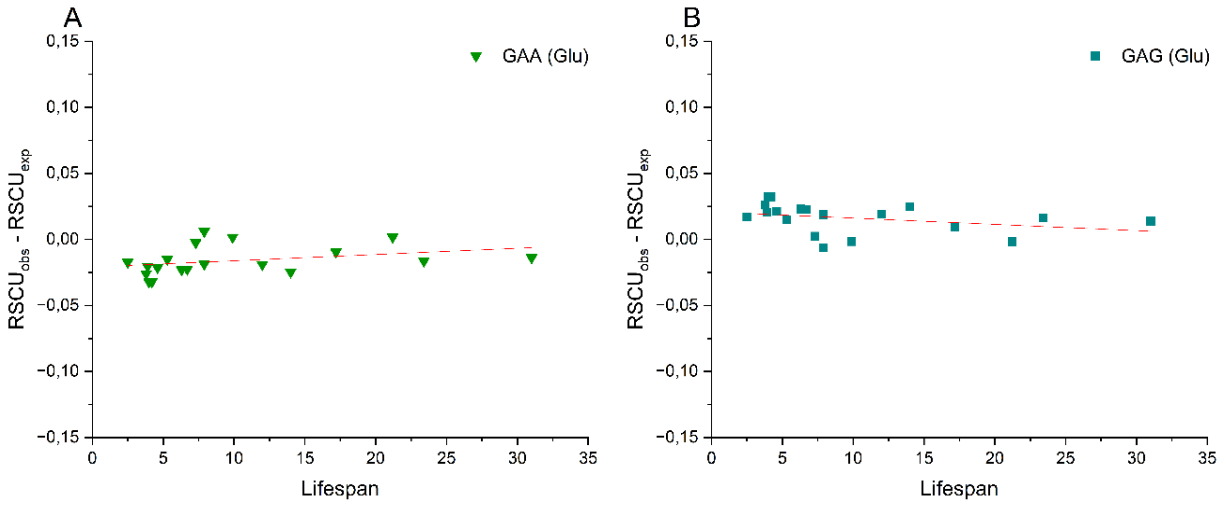
Supplementary figure 5.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **cysteine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



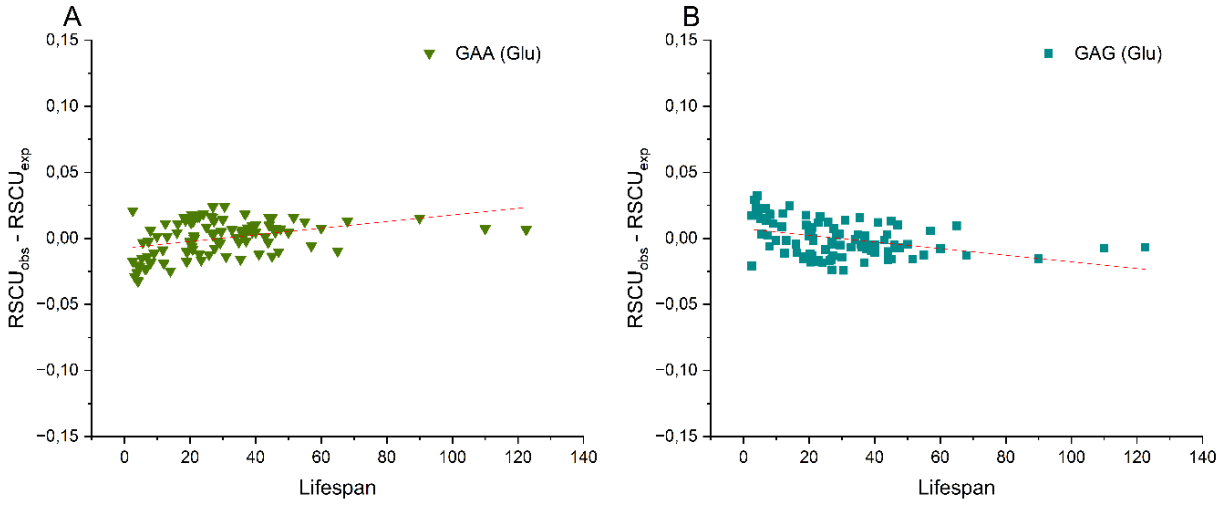
Supplementary figure 6.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **glutamine**, plotted against maximum lifespan (years) of 19 **rodent** species.



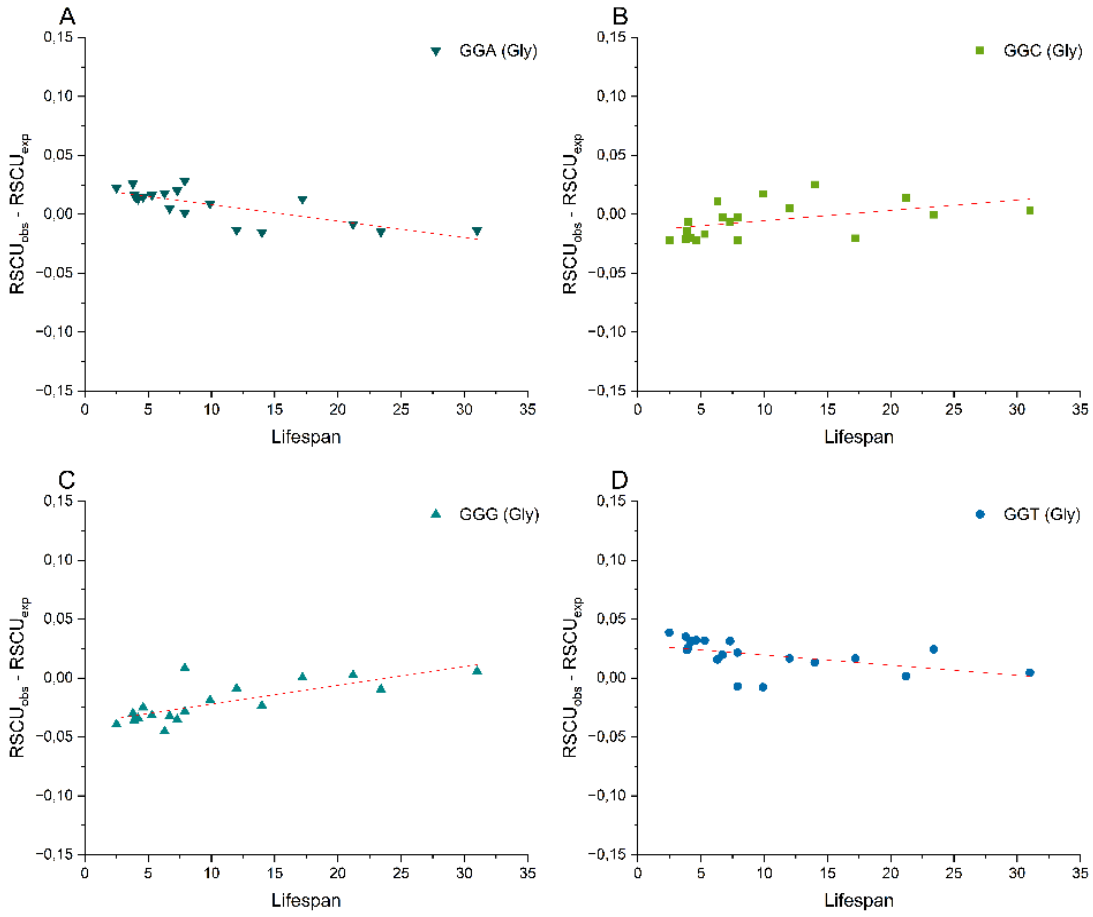
Supplementary figure 6.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **glutamine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



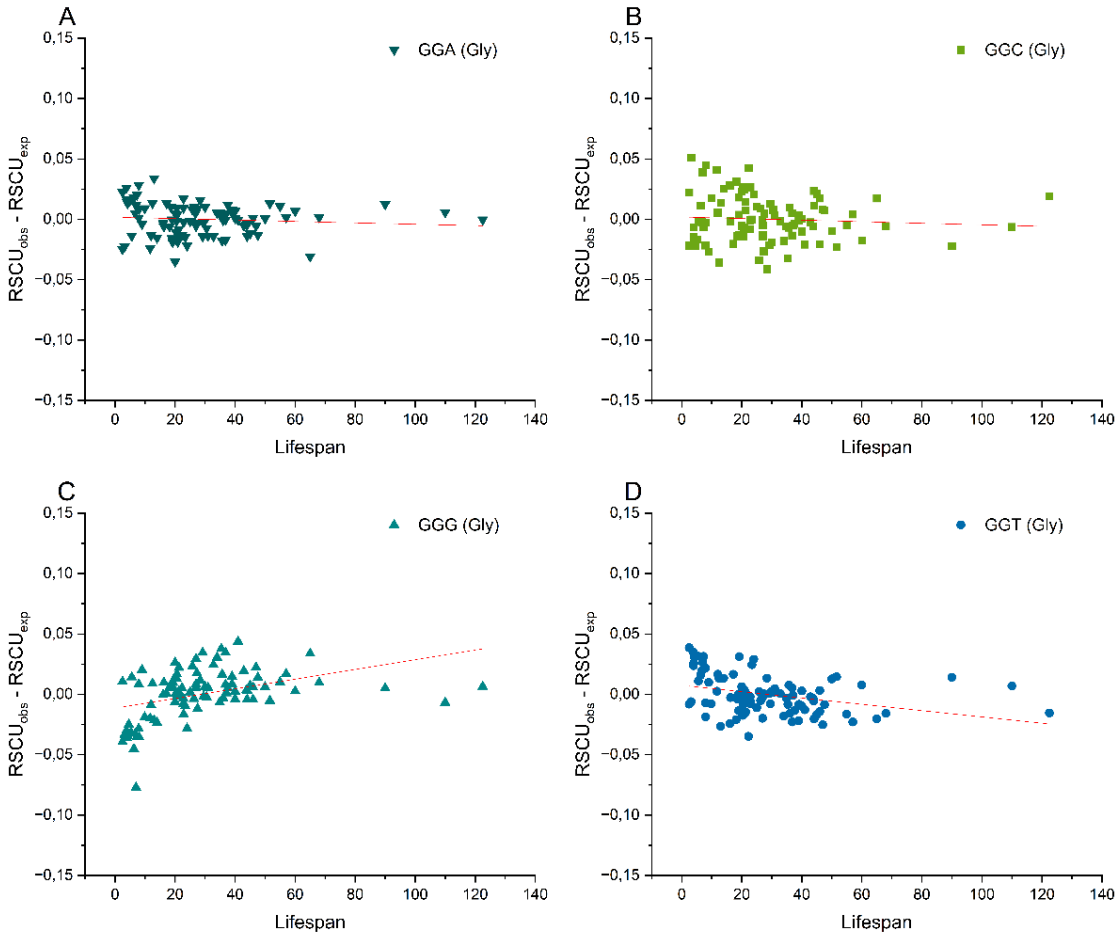
Supplementary figure 7.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **glutamic acid**, plotted against maximum lifespan (years) of 19 **rodent** species.



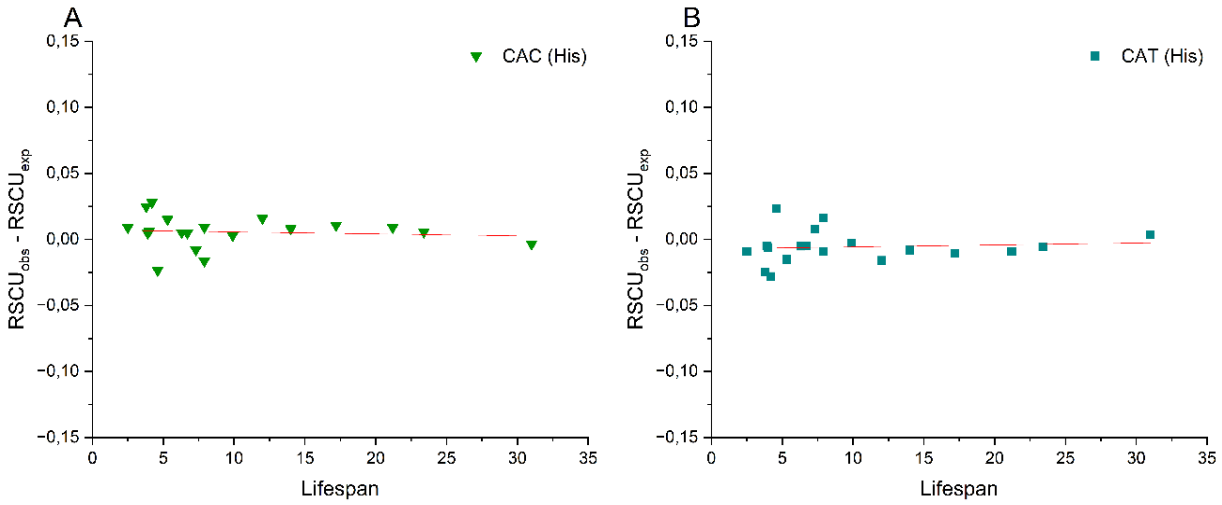
Supplementary figure 7.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **glutamic acid**, plotted against maximum lifespan (years) of 96 **mammalian** species.



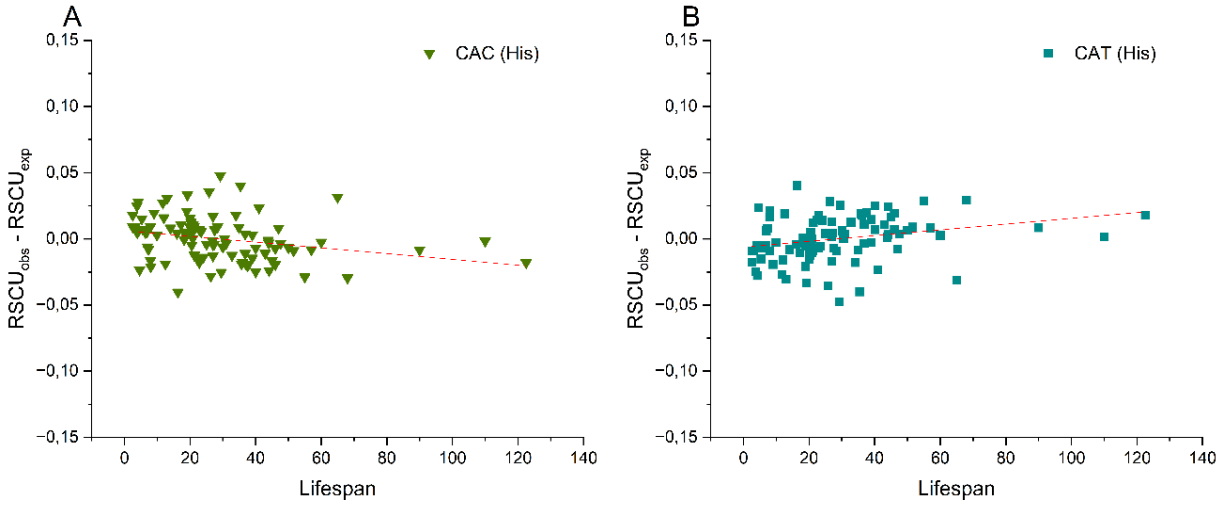
Supplementary figure 8.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **glycine**, plotted against maximum lifespan (years) of 19 **rodent** species.



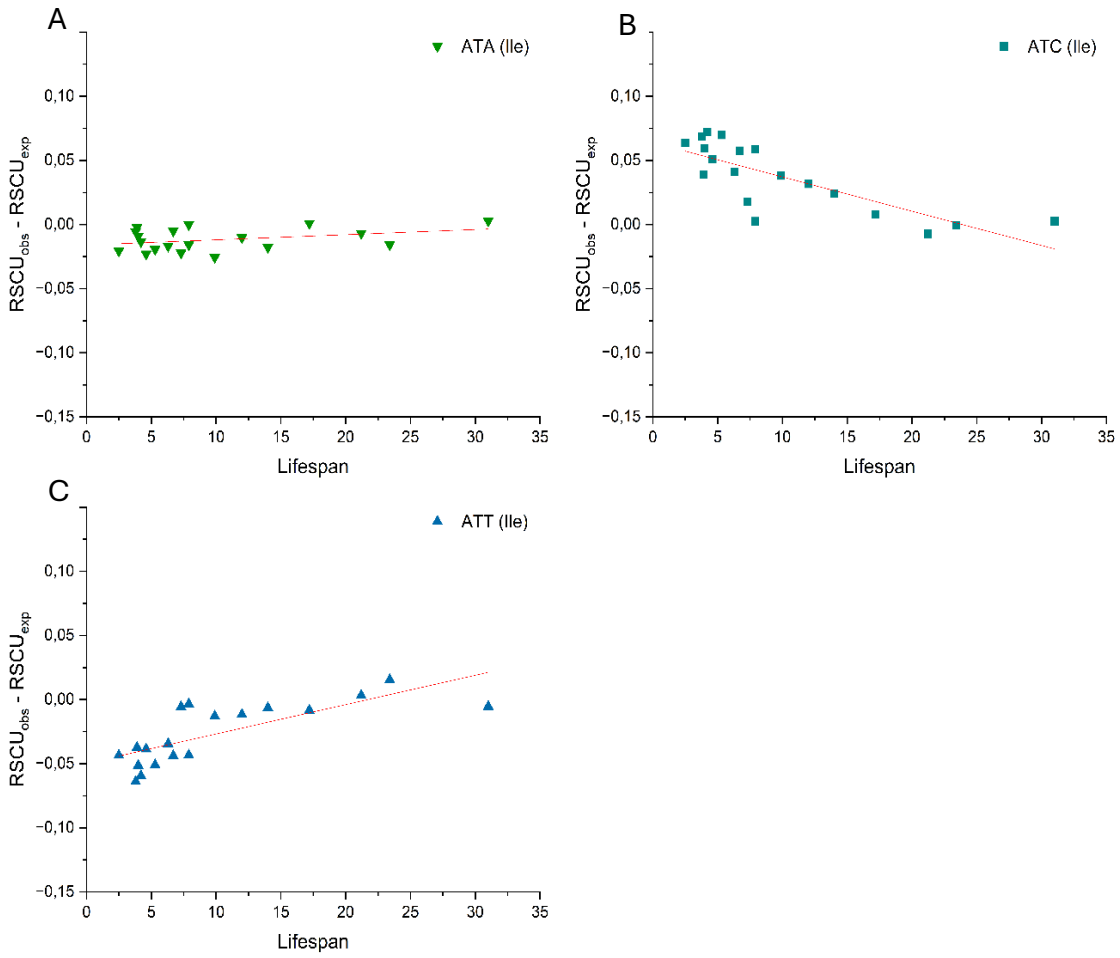
Supplementary figure 8.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **glycine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



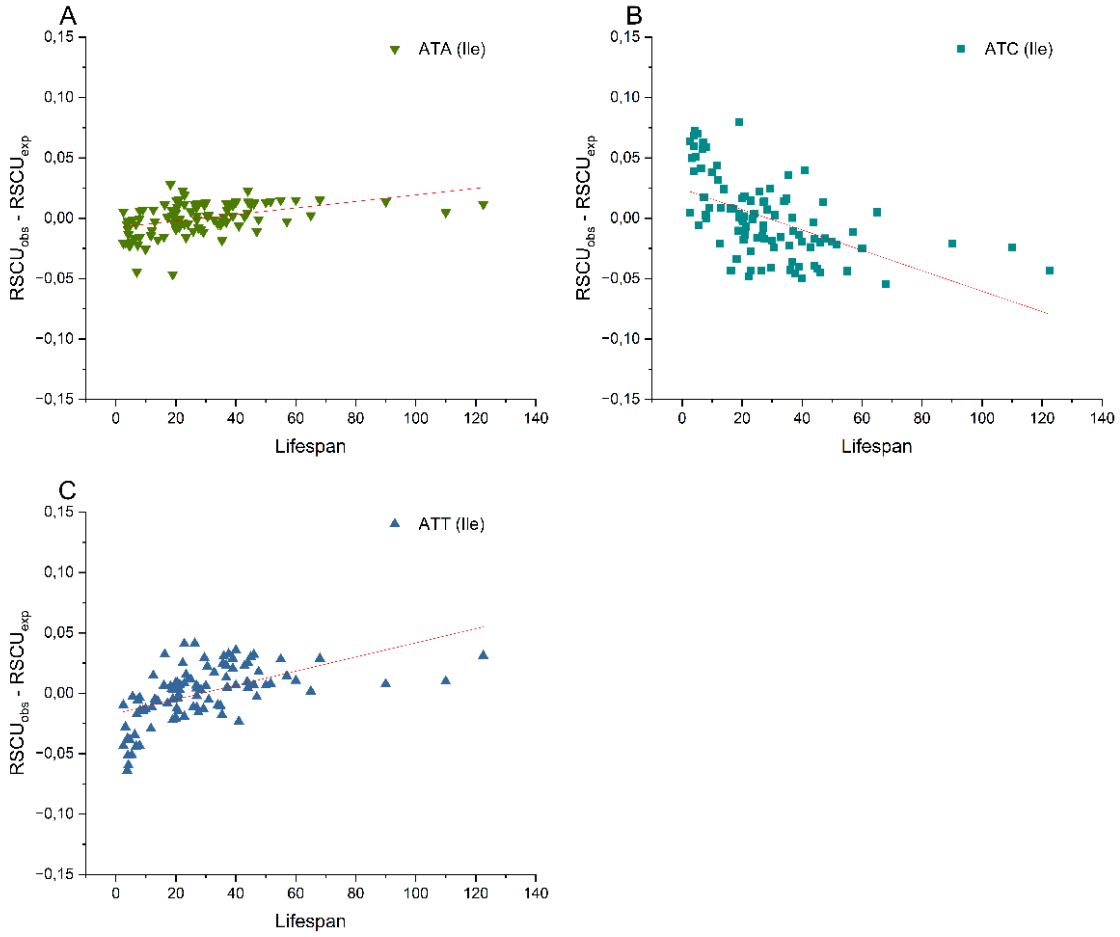
Supplementary figure 9.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **histidine**, plotted against maximum lifespan (years) of 19 **rodent** species.



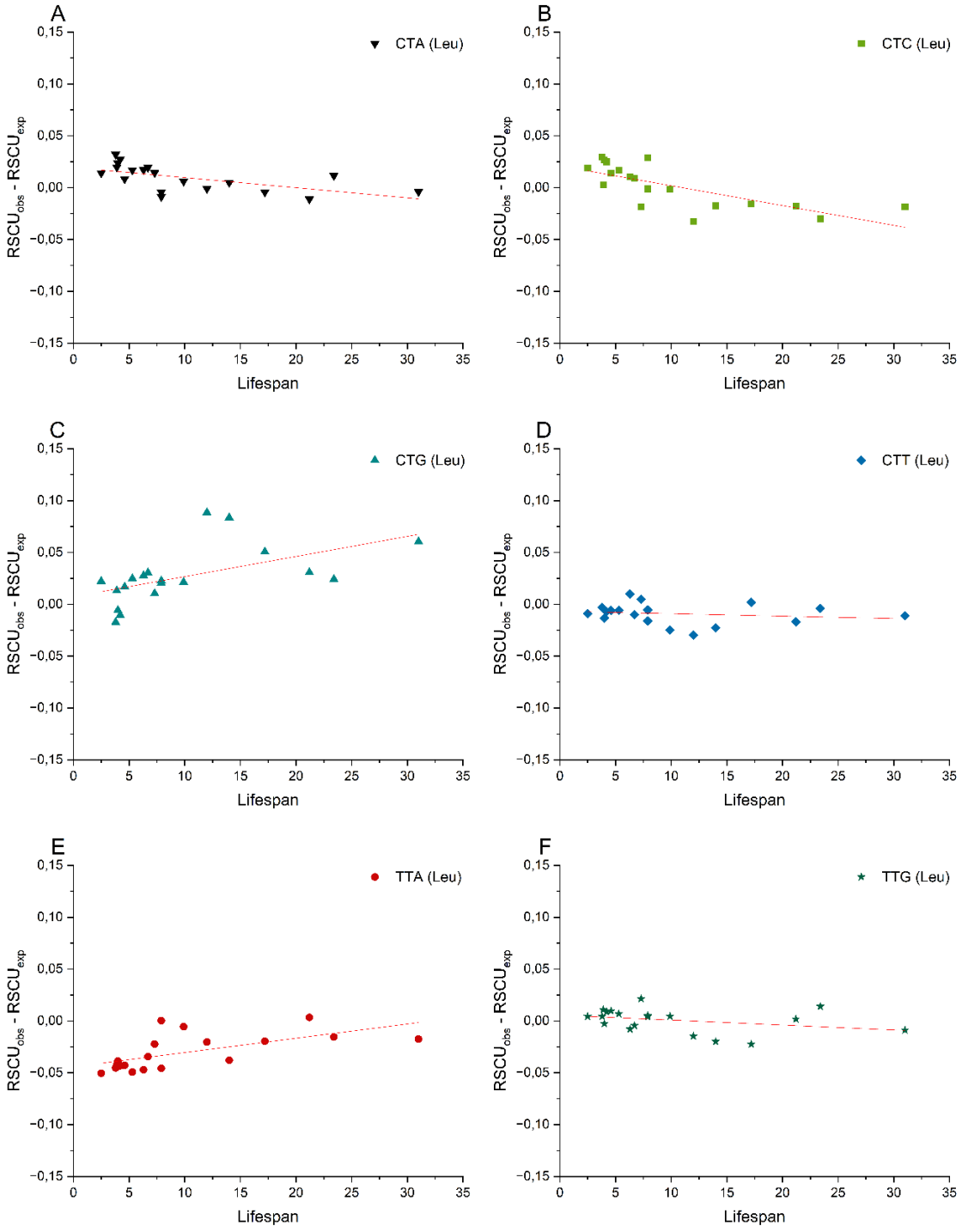
Supplementary figure 9.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **histidine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



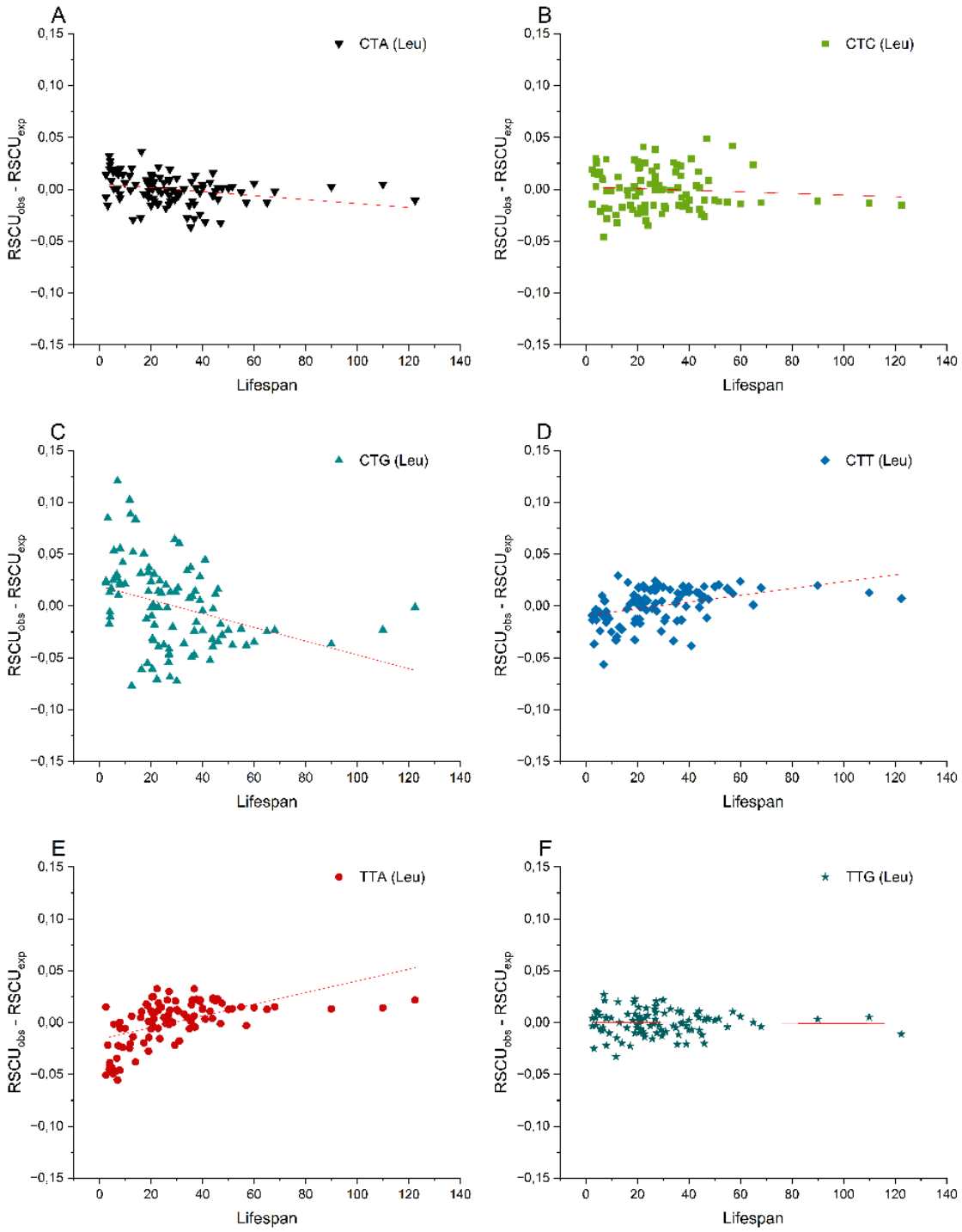
Supplementary figure 10.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **isoleucine**, plotted against maximum lifespan (years) of 19 **rodent** species.



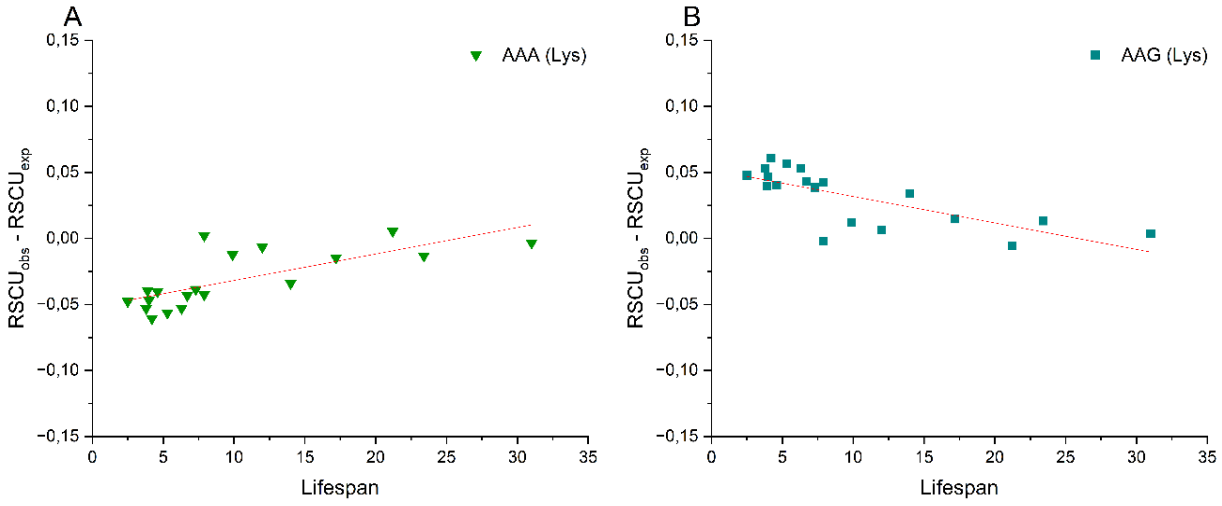
Supplementary figure 10.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **isoleucine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



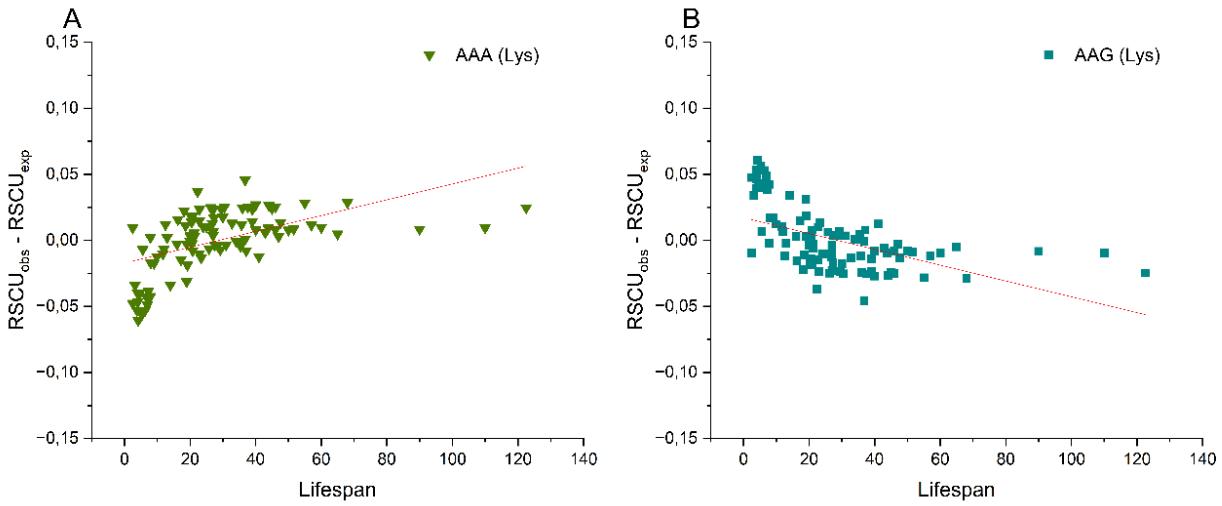
Supplementary figure 11.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **leucine**, plotted against maximum lifespan (years) of 19 **rodent** species.



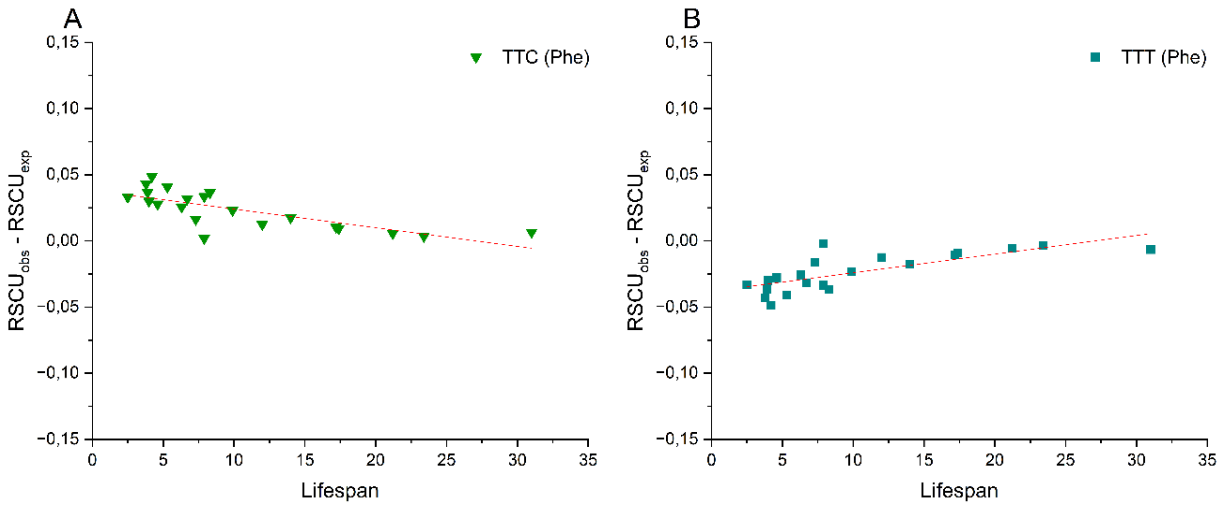
Supplementary figure 11.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **leucine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



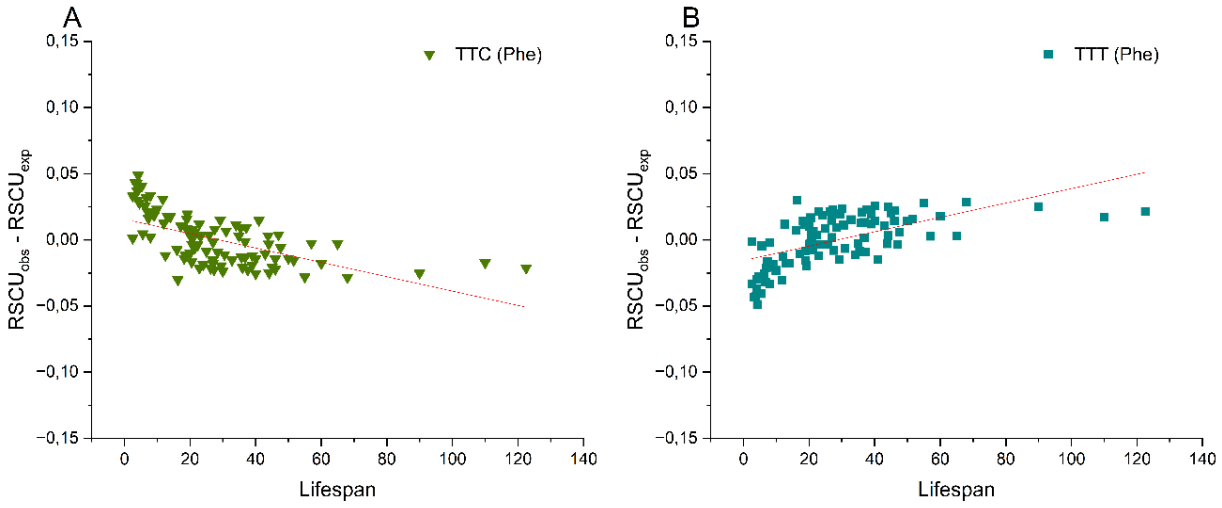
Supplementary figure 12.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **lysine**, plotted against maximum lifespan (years) of 19 **rodent** species.



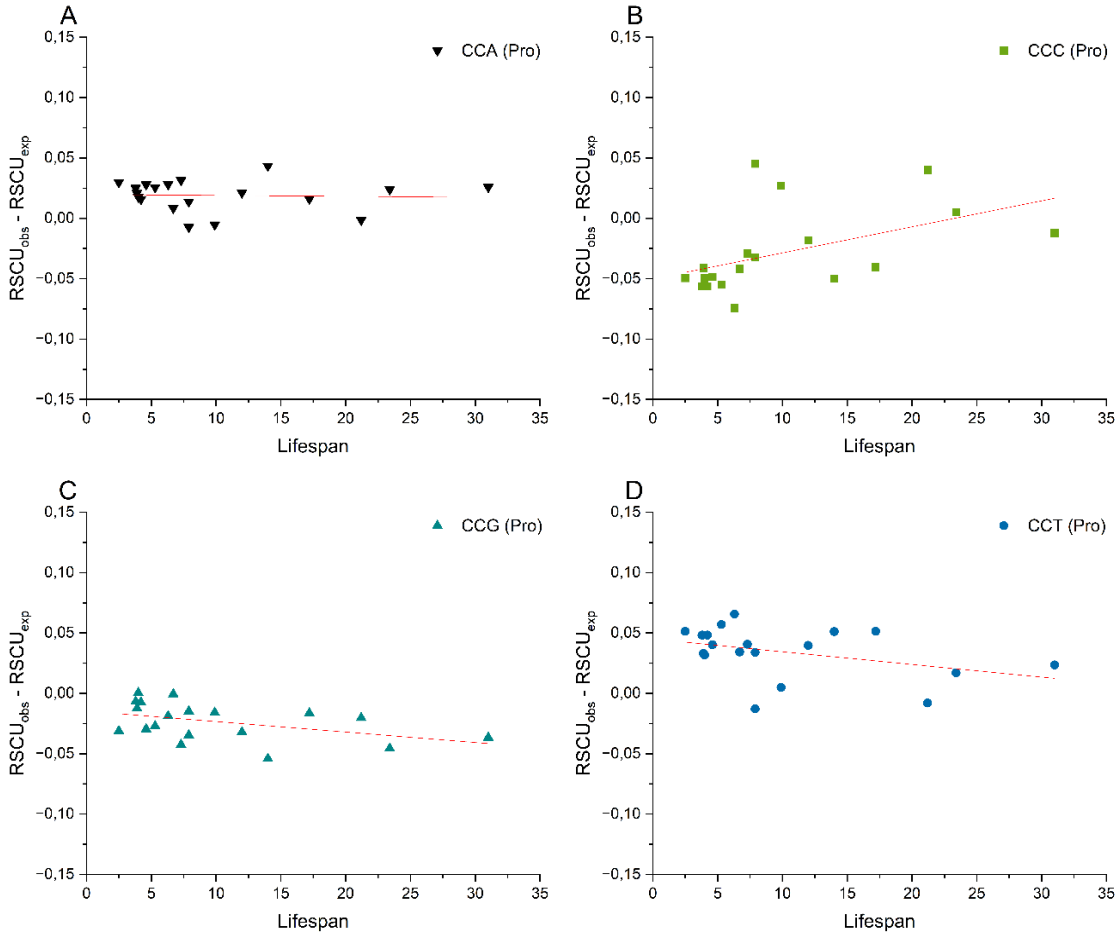
Supplementary figure 12.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **lysine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



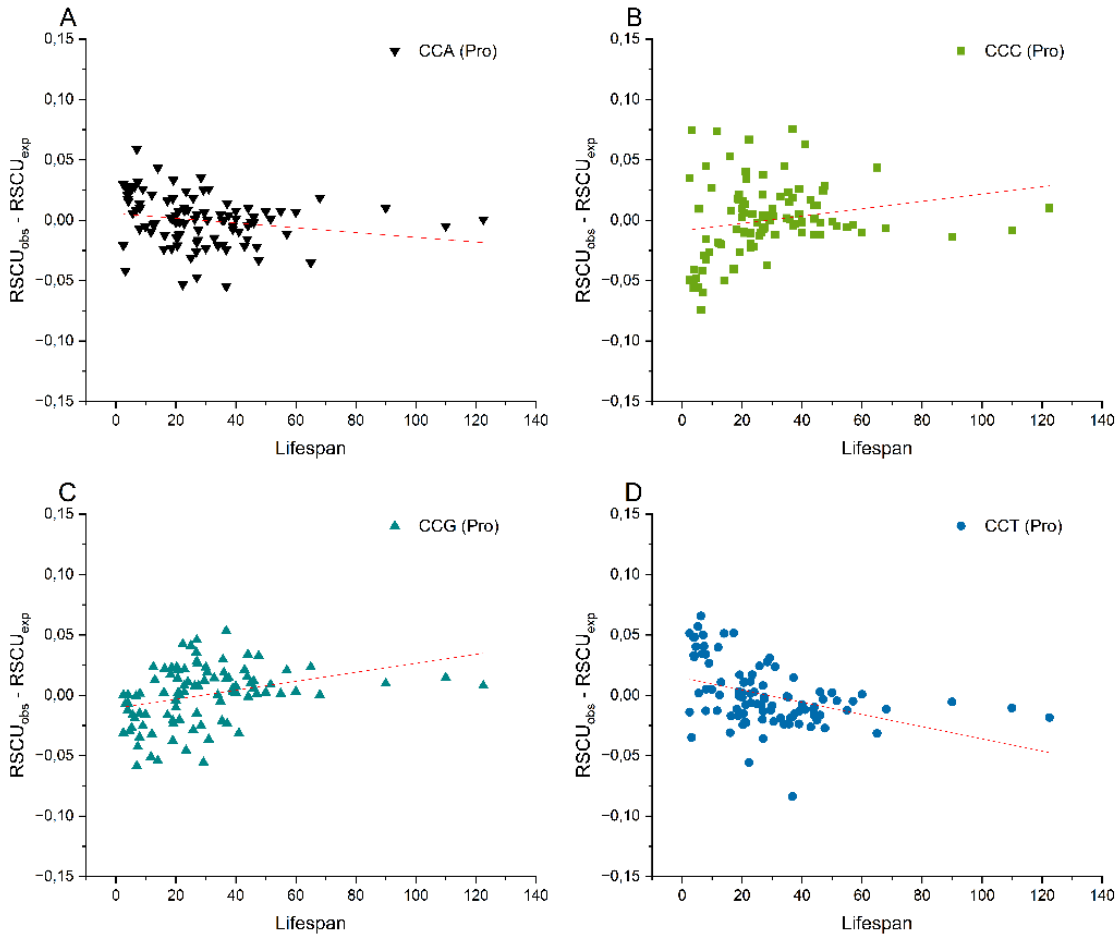
Supplementary figure 13.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **phenylalanine**, plotted against maximum lifespan (years) of 19 **rodent** species.



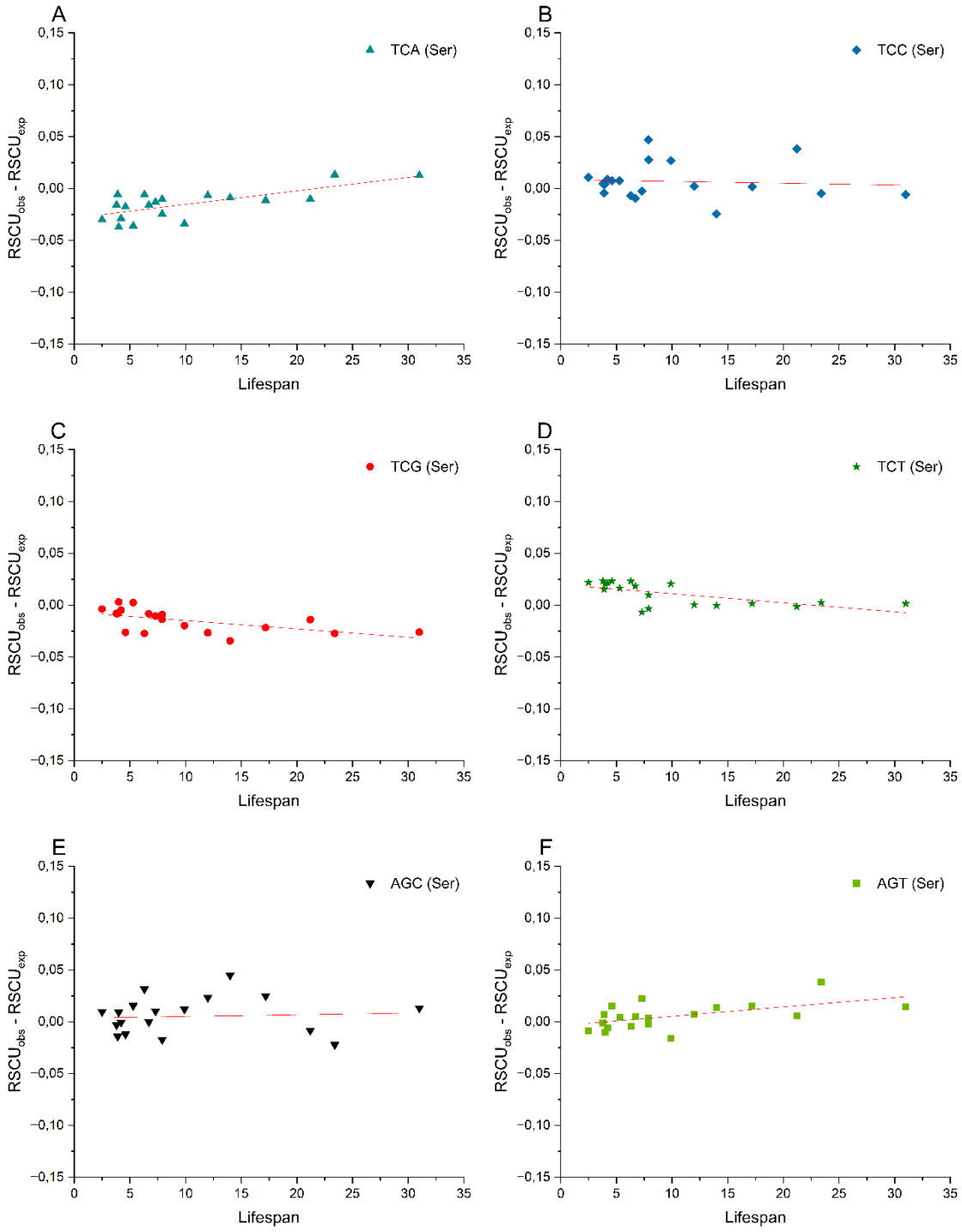
Supplementary figure 13.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **phenylalanine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



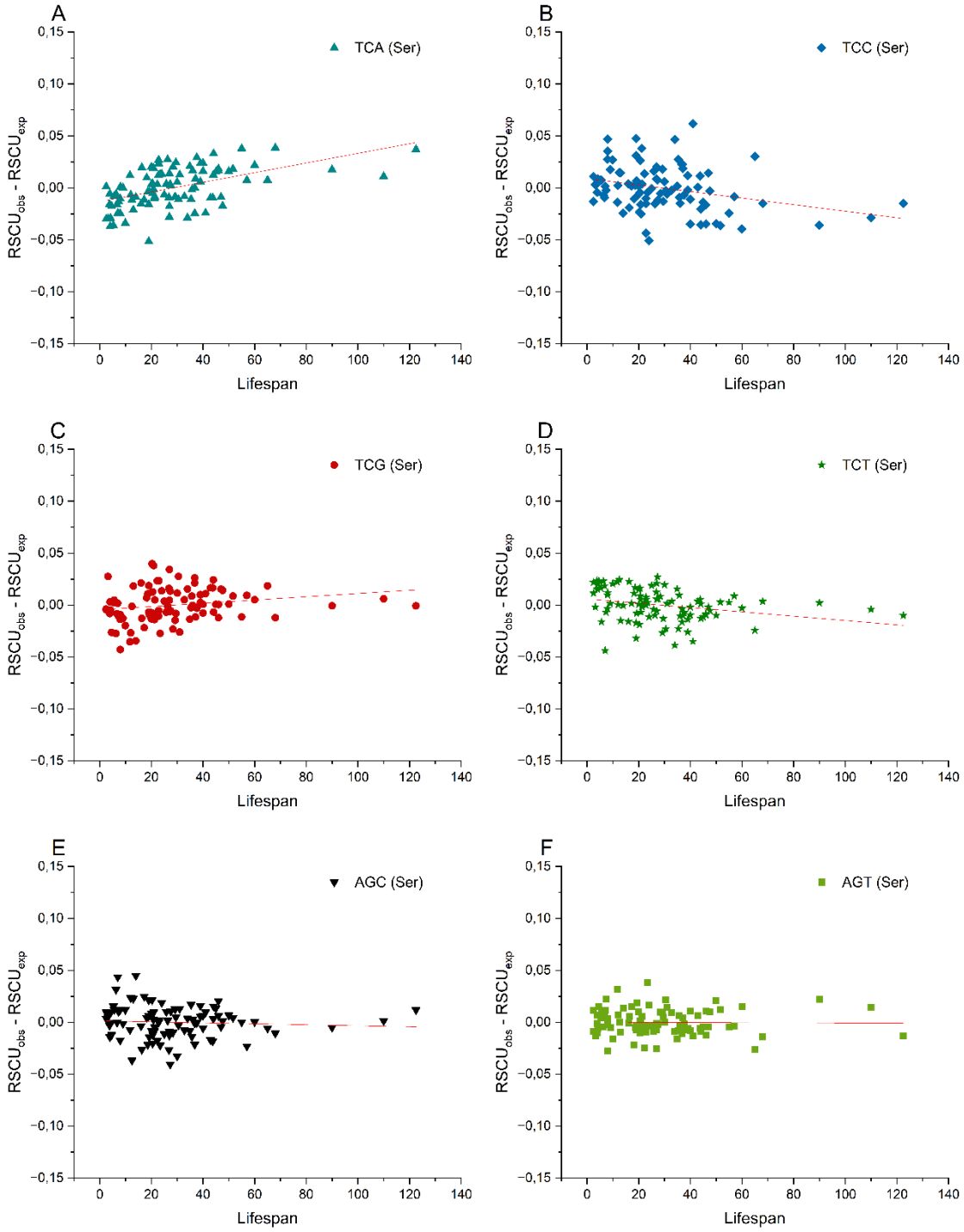
Supplementary figure 14.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **proline**, plotted against maximum lifespan (years) of 19 **rodent** species.



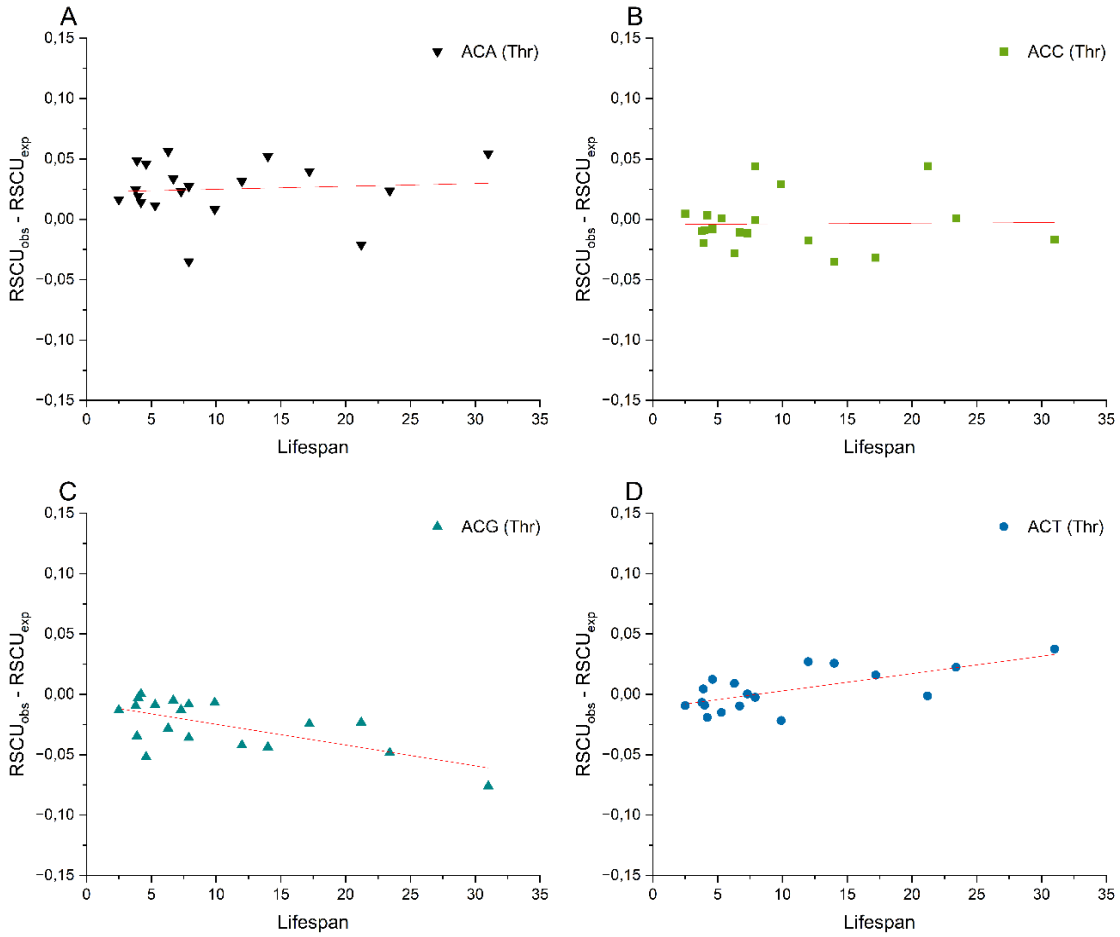
Supplementary figure 14.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **proline**, plotted against maximum lifespan (years) of 96 **mammalian** species.



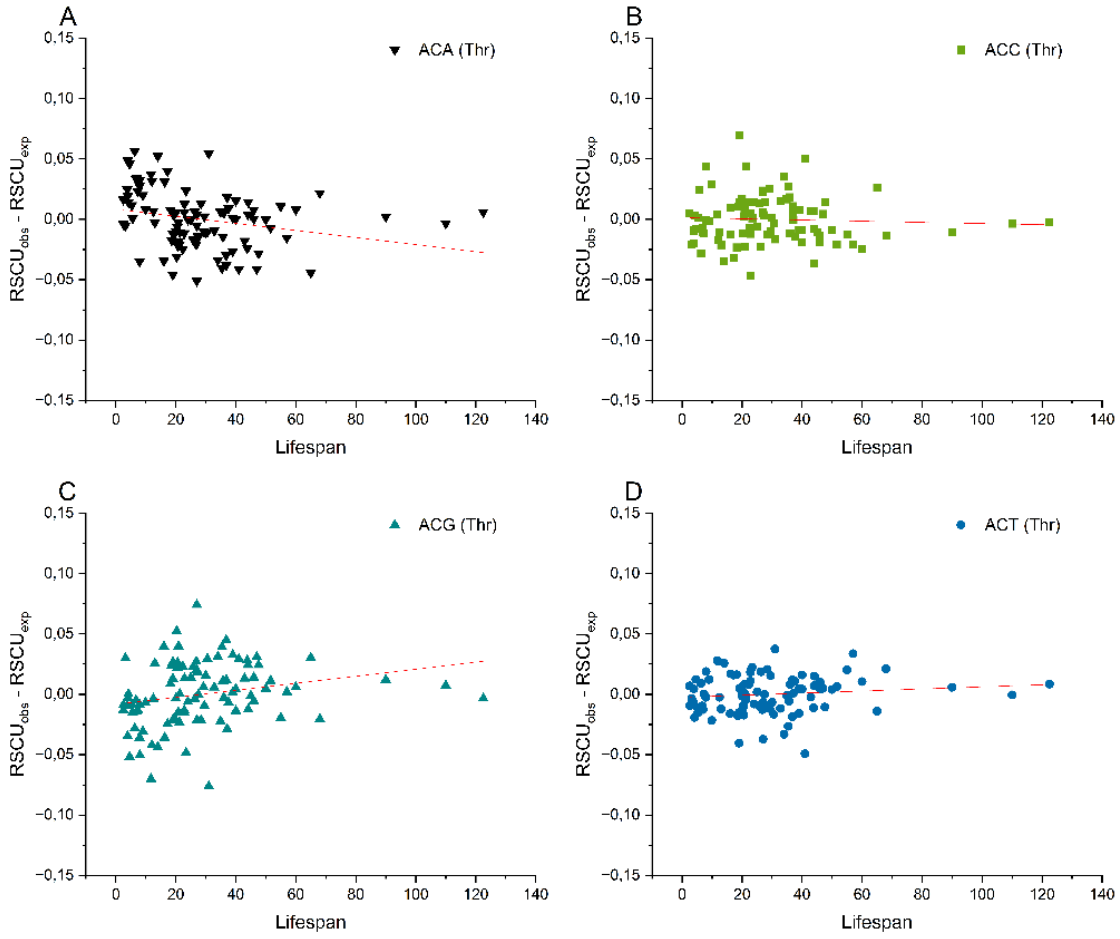
Supplementary figure 15.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **serine**, plotted against maximum lifespan (years) of 19 **rodent** species.



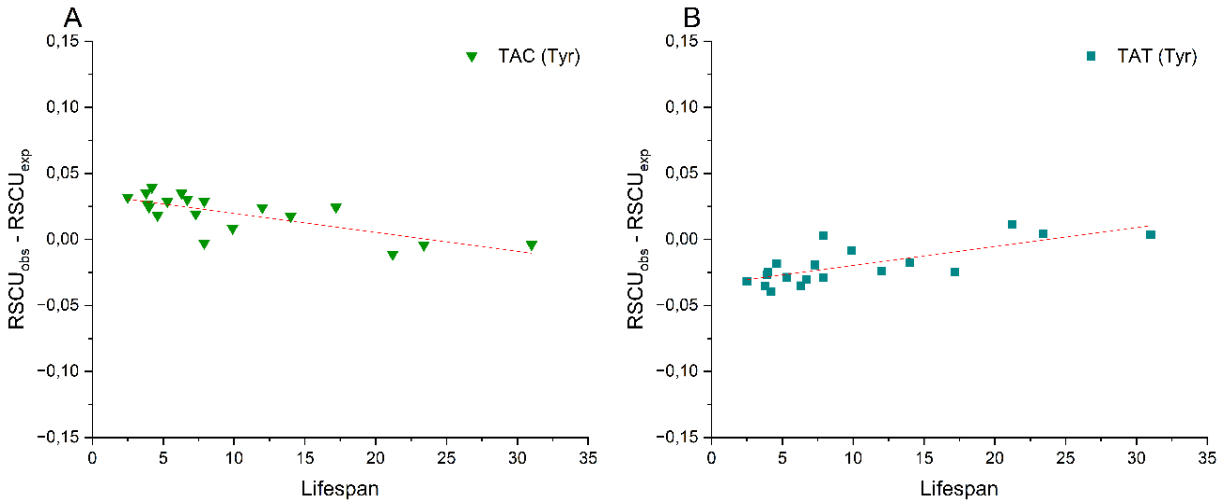
Supplementary figure 15.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **serine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



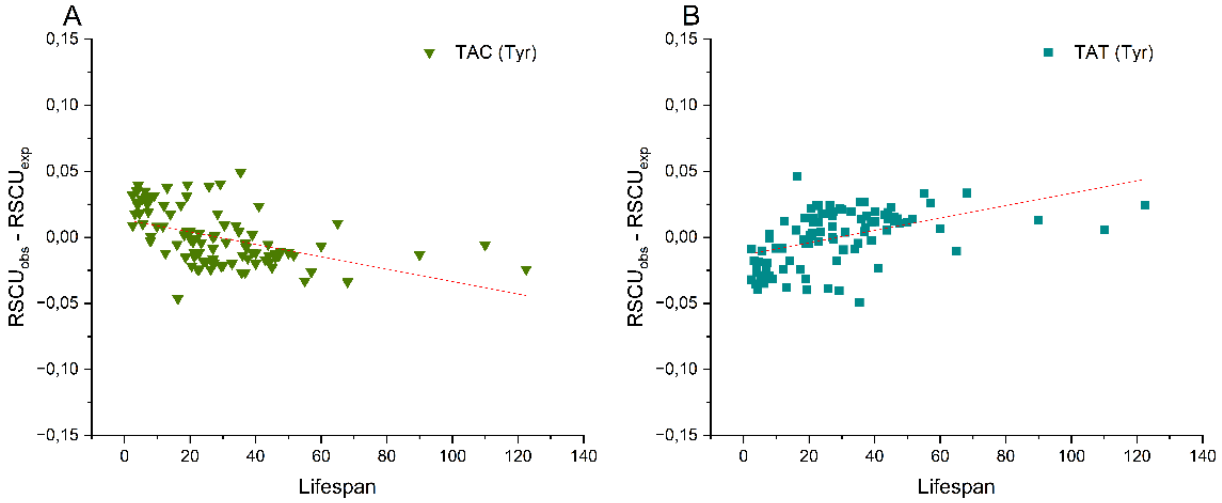
Supplementary figure 16.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **threonine**, plotted against maximum lifespan (years) of 19 **rodent** species.



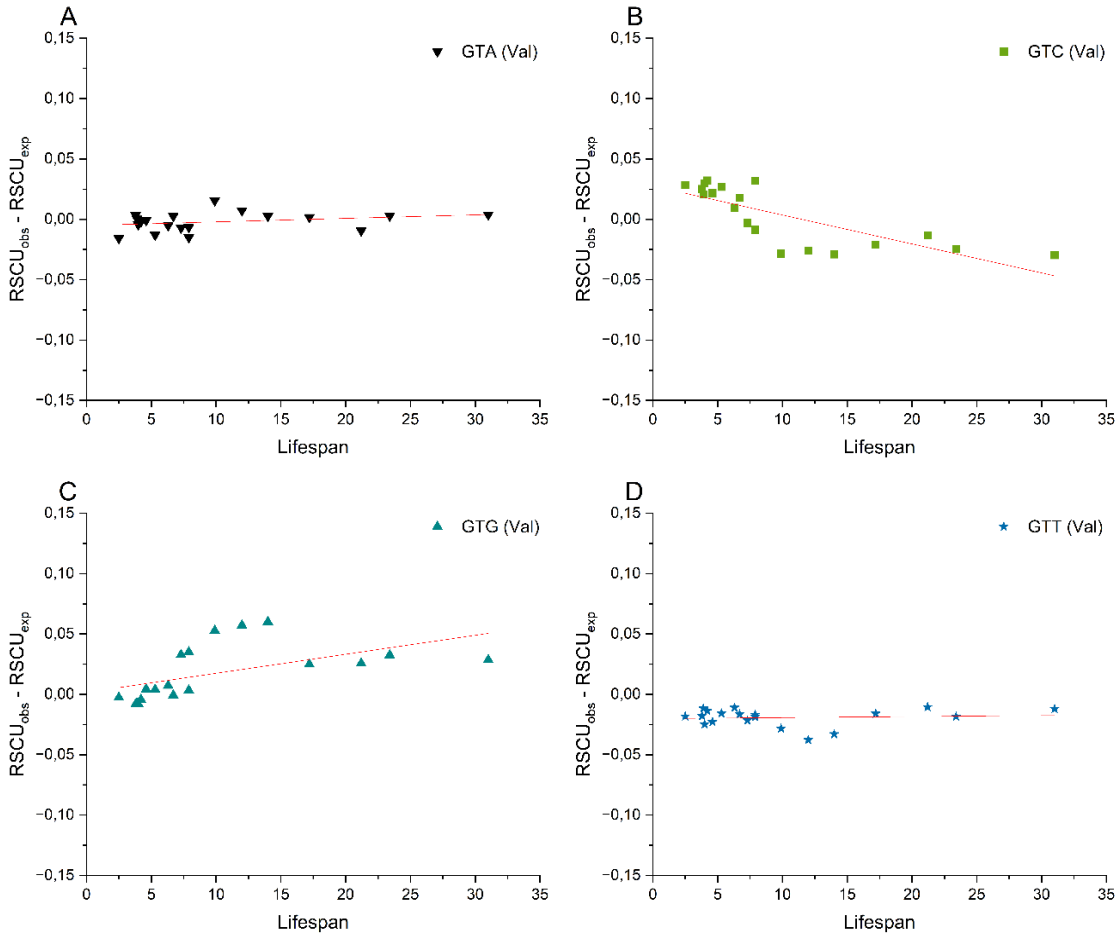
Supplementary figure 16.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **threonine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



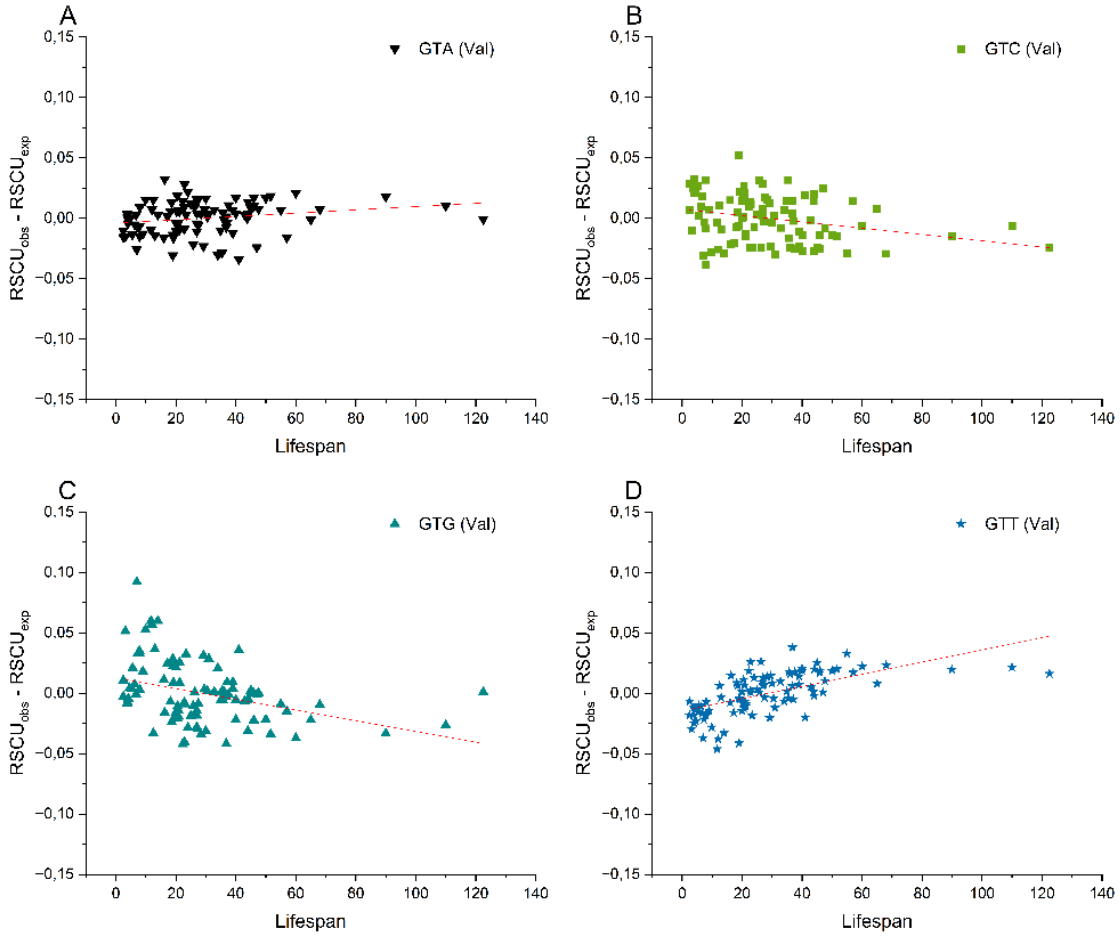
Supplementary figure 17.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **tyrosine**, plotted against maximum lifespan (years) of 19 **rodent** species.



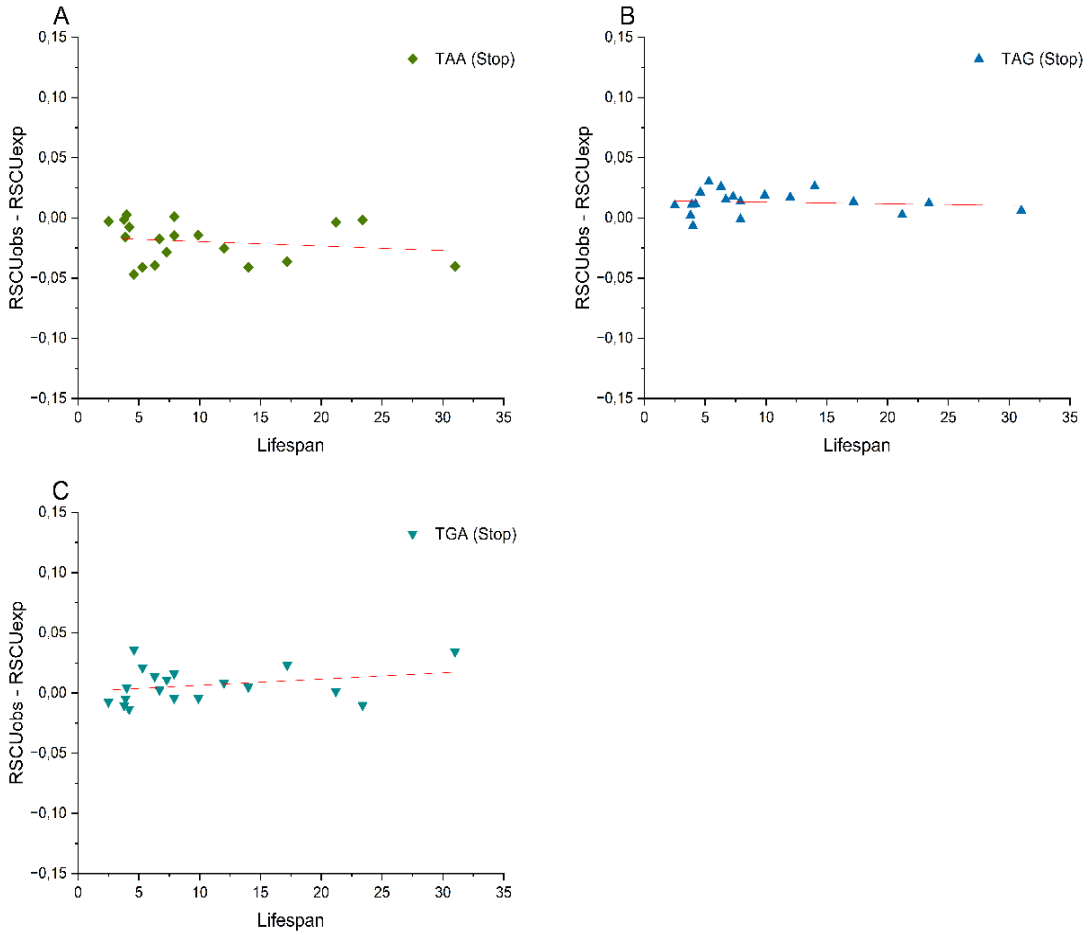
Supplementary figure 17.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **tyrosine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



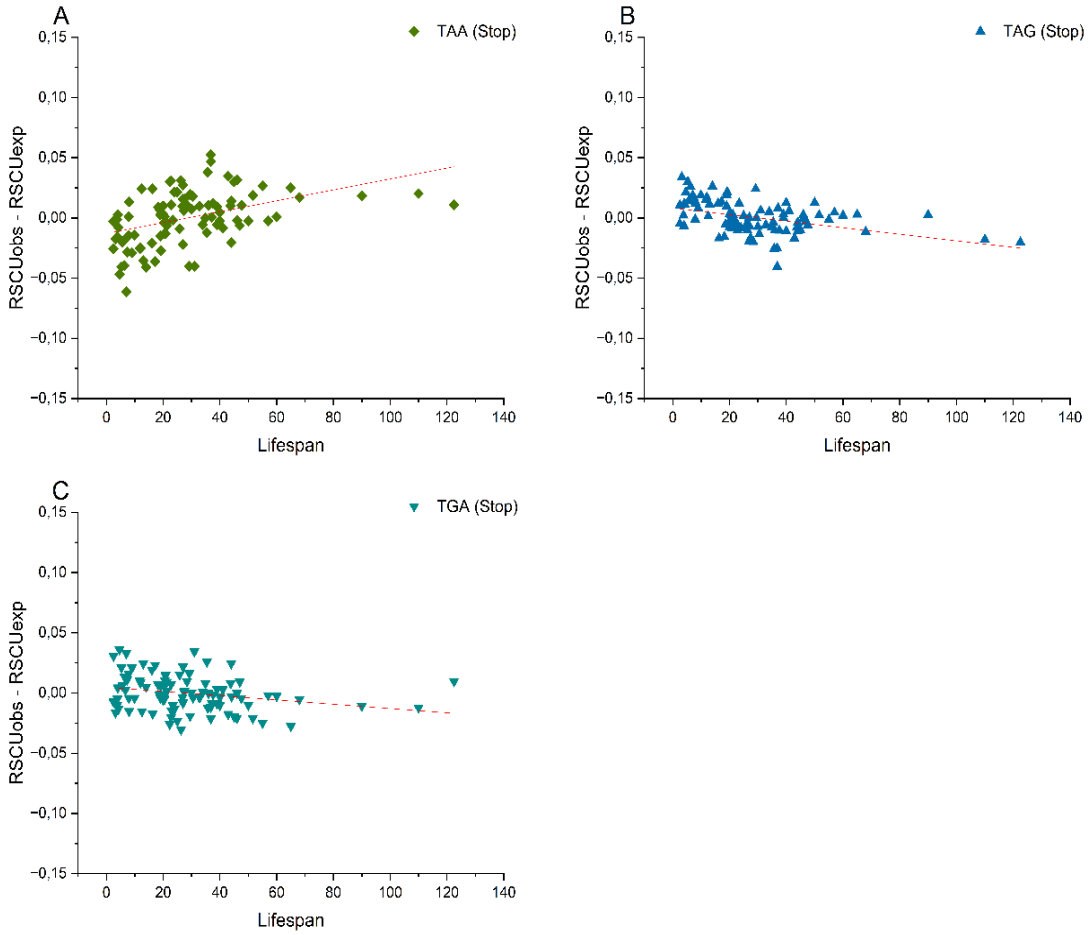
Supplementary figure 18.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **valine**, plotted against maximum lifespan (years) of 19 **rodent** species.



Supplementary figure 18.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for codons encoding **valine**, plotted against maximum lifespan (years) of 96 **mammalian** species.



Supplementary figure 19.a. Differences between observed and expected relative synonymous codon usage (RSCU) values for **stop** codons, plotted against maximum lifespan (years) of 19 **rodent** species.



Supplementary figure 19.b. Differences between observed and expected relative synonymous codon usage (RSCU) values for **stop** codons, plotted against maximum lifespan (years) of 96 **mammalian** species.

Copy number of tRNA genes in metazoa and impact of GC content of coding genomes and lifespan on relative synonymous codon usage (RSCU) of mammalian species

Note: Data for synonymous codons with the highest and lowest numbers of matching isodecoder tRNA genes in metazoa are shown in green and red, respectively

		Copy number of tRNA genes in metazoa						Copy number of tRNA genes in mammals					Copy number of tRNA genes in mammalian species analyzed in this study				
Codon	$RSCU_{GC50}$	Amino acid	Anticodon (tRNA)	Codon (RNA)	Fraction of species lacking the tRNA gene	Mean of tRNA gene copy number	Median of tRNA gene copy number	Anticodon (tRNA)	Codon (RNA)	Fraction of species lacking the tRNA gene	Mean of tRNA gene copy number	Median of tRNA gene copy number	Anticodon (tRNA)	Codon (RNA)	Fraction of species lacking the tRNA gene	Mean of tRNA gene copy number	Median of tRNA gene copy number
Ala																	
GCA	1,071	Alanine	UGC	GCA	0	13,32	8	UGC	GCA	0	13,62	9	UGC	GCA	0	16,30	9
GCC	1,401	Alanine	GGC	GCC	0,794	2,77	0	GGC	GCC	0,759	3,34	0	GGC	GCC	0,727	5,70	0
GCG	0,267	Alanine	CGC	GCG	0	7,45	4	CGC	GCG	0	7,24	5	CGC	GCG	0	8,64	5
GCT	1,261	Alanine	AGC	GCU	0	19,49	14	AGC	GCU	0	20,10	15	AGC	GCU	0	23,67	16
Arg																	
AGA	1,475	Arginine	UCU	AGA	0	10,51	5	UCU	AGA	0	8,60	6	UCU	AGA	0	8,06	6
AGG	1,354	Arginine	CCU	AGG	0	9,97	5	CCU	AGG	0	9,76	7	CCU	AGG	0	8,70	7
CGA	0,734	Arginine	UCG	CGA	0	9,15	5	UCG	CGA	0	6,84	5,5	UCG	CGA	0	5,82	5
CGC	0,895	Arginine	GCG	CGC	0,928	0,19	0	GCG	CGC	0,828	0,36	0	GCG	CGC	0,758	0,52	0
CGG	0,992	Arginine	CCG	CGG	0,354	2,55	2	CCG	CGG	0	4,05	3,5	CCG	CGG	0	3,67	3
CGT	0,554	Arginine	ACG	CGU	0	12,01	7	ACG	CGU	0	7,05	7	ACG	CGU	0	6,79	6
Asn																	
AAC	0,99	Asparagine	GUU	AAC	0	18,61	13	GUU	AAC	0	15,48	15	GUU	AAC	0	15,36	15
AAT	1,01	Asparagine	AUU	AAU	0,785	0,65	0	AUU	AAU	0,603	0,86	0	AUU	AAU	0,576	1,03	0
Asp																	
GAC	0,978	Aspartic Acid	GUC	GAC	0	20,25	12	GUC	GAC	0	13,62	12	GUC	GAC	0	13,39	12
GAT	1,023	Aspartic Acid	AUC	GAU	0,897	0,68	0	AUC	GAU	0,793	1,98	0	AUC	GAU	0,848	3,12	0
Cys																	
TGC	0,953	Cysteine	GCA	UGC	0	17,85	13	GCA	UGC	0	25,71	22	GCA	UGC	0	26,45	22
TGT	1,047	Cysteine	ACA	UGU	0,789	0,49	0	ACA	UGU	0,672	0,53	0	ACA	UGU	0,636	0,52	0
Gln																	
CAA	0,596	Glutamine	UUG	CAA	0	9,78	6	UUG	CAA	0	6,28	5	UUG	CAA	0	5,21	5
CAG	1,404	Glutamine	CUG	CAG	0	13,44	8	CUG	CAG	0	11,33	10,5	CUG	CAG	0	10,82	10
Glu																	
GAA	0,922	Glutamic Aci	UUC	GAA	0	16,17	9	UUC	GAA	0	15,62	9	UUC	GAA	0	14,00	9
GAG	1,078	Glutamic Aci	CUC	GAG	0	16,78	10	CUC	GAG	0	16,55	13	CUC	GAG	0	14,09	12
Gly																	
GGA	1,14	Glycine	UCC	GGA	0	16,55	8	UCC	GGA	0	17,67	9	UCC	GGA	0	16,64	9
GGC	1,169	Glycine	GCC	GGC	0	18,86	12	GCC	GGC	0	14,69	13	GCC	GGC	0	13,85	12
GGG	0,92	Glycine	CCC	GGG	0,054	6,76	3	CCC	GGG	0	10,95	5,5	CCC	GGG	0	9,21	6
GGT	0,772	Glycine	ACC	GGU	0,870	0,81	0	ACC	GGU	0,741	2,66	0	ACC	GGU	0,758	4,21	0
His																	
CAC	1,043	Histidine	GUG	CAC	0	12,90	8	GUG	CAC	0	8,74	9	GUG	CAC	0	8,61	8
CAT	0,957	Histidine	AUG	CAU	0,928	0,10	0	AUG	CAU	0,898	0,14	0	AUG	CAU	0,848	0,24	0
Ile																	
ATA	0,558	Isoleucine	UAU	AUA	0,004	7,05	4	UAU	AUA	0	5,81	5	UAU	AUA	0	6,24	5
ATC	1,283	Isoleucine	GAU	AUC	0,780	2,41	0	GAU	AUC	0,690	0,72	0	GAU	AUC	0,667	1,03	0
ATT	1,162	Isoleucine	AAU	AUU	0	15,97	10	AAU	AUU	0	12,55	11	AAU	AUU	0	13,36	11
Leu																	
CTA	0,535	Leucine	UAG	CUA	0,013	6,11	3	UAG	CUA	0	3,98	4	UAG	CUA	0	4,00	4
CTC	1,084	Leucine	GAG	CUC	0,946	0,07	0	GAG	CUC	0,983	0,02	0	GAG	CUC	1	0,00	0
CTG	2,1	Leucine	CAG	CUG	0	10,63	6	CAG	CUG	0	7,48	6	CAG	CUG	0	7,33	7
CTT	0,915	Leucine	AAG	CUU	0	9,35	5	AAG	CUU	0	6,21	6	AAG	CUU	0	6,42	5
TTA	0,497	Leucine	UAA	UUA	0	7,43	4	UAA	UUA	0	3,83	4	UAA	UUA	0	3,73	4
TTG	0,87	Leucine	CAA	UUG	0	9,57	5	CAA	UUG	0	5,47	5	CAA	UUG	0	5,36	5
Lys																	
AAA	0,907	Lysine	UUU	AAA	0	17,98	11	UUU	AAA	0	16,98	15	UUU	AAA	0	15,09	14
AAG	1,093	Lysine	CUU	AAG	0	24,22	13	CUU	AAG	0	34,98	18	CUU	AAG	0	33,52	18
ATG	1	Methionine	CAU	AUG	0	24,04	16	CAU	AUG	0	18,55	18	CAU	AUG	0	18,73	18
Phe																	
TTC	1,003	Phenylalanin	GAA	UUC	0,004	16,22	9	GAA	UUC	0	10,81	10	GAA	UUC	0	10,91	10
TTT	0,997	Phenylalanin	AAA	UUU	0,848	0,74	0	AAA	UUU	0,914	0,17	0	AAA	UUU	0,882	0,24	0
Pro																	
CCA	1,294	Proline	UGG	CCA	0,004	11,20	6	UGG	CCA	0	6,62	6	UGG	CCA	0	6,39	6
CCC	1,095	Proline	GGG	CCC	0,915	0,49	0	GGG	CCC	0,897	0,16	0	GGG	CCC	0,879	0,21	0
CCG	0,269	Proline	CGG	CCG	0	5,79	3	CGG	CCG	0	3,47	3	CGG	CCG	0	3,36	3
CCT	1,342	Proline	AGG	CCU	0	12,42	8	AGG	CCU	0	9,53	8	AGG	CCU	0	10,12	8
Ser																	
AGC	1,281	Serine	GCU	AGC	0	13,50	7	GCU	AGC	0	9,57	9	GCU	AGC	0	9,45	8
AGT	1,021	Serine	ACU	AGU	0,861	0,33	0	ACU	AGU	0,793	0,43	0	ACU	AGU	0,818	0,55	0
TCA	1,019	Serine	UGA	UCA	0	8,35	4	UGA	UCA	0	4,05	4	UGA	UCA	0	3,91	4
TCC	1,187	Serine	GGA	UCC	0,834	2,39	0	GGA	UCC	0,897	0,38	0	GGA	UCC	0,848	0,58	0
TCG	0,206	Serine	CGA	UCG	0,013	6,52	3	CGA	UCG	0	3,72	4	CGA	UCG	0	3,61	4
TCT	1,286	Serine	AGA	UCU	0	17,17	8	AGA	UCU	0	11,59	9	AGA	UCU	0	13,21	9
Thr																	
ACA	1,315	Threonine	UGU	ACA	0	13,91	6	UGU	ACA	0	6,95	6	UGU	ACA	0	7,03	6
ACC	1,27	Threonine	GGU	ACC	0,812	3,35	0	GGU	ACC	0,845	1,57	0	GGU	ACC	0,788	2,70	0
ACG	0,268	Threonine	CGU	ACG	0,009	7,92	4	CGU	ACG	0	4,55	4	CGU	ACG	0	4,64	4
ACT	1,149	Threonine	AGU	ACU	0	16,92	9	AGU	ACU	0	12,07	10	AGU	ACU	0	13,52	9
Trp																	
TGG	1	Tryptophan	CCA	UGG	0	11,83	7	CCA	UGG	0	10,16	8	CCA	UGG	0	9,06	7
Tyr																	
TAC	1,009	Tyrosine	GUA	UAC	0	17,23	11	GUA	UAC	0	11,21	11	GUA	UAC	0	10,85	11
TAT	0,991	Tyrosine	AUA	UAU	0,906	0,22	0	AUA	UAU	0,862	0,14	0	AUA	UAU	0,818	0,18	0
Val																	
GTA	0,568	Valine	UAC	GUA	0	8,54	4	UAC	GUA	0	7,28	5,5	UAC	GUA	0	7,61	5
GTC	0,911	Valine	GAC	GUC	0,695	1,14	0	GAC	GUC	0,741	0,78	0	GAC	GUC	0,727	1,09	0
GTG	1,715	Valine	CAC	GUG	0	10,76	7	CAC	GUG	0	11,81	10	CAC	GUG	0	13,52	10
GTT	0,801	Valine	AAC	GUU	0	14,24	8	AAC	GUU	0	11,09	8	AAC	GUU	0	12,94	8
Stop																	
TAA	0,906	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TAG	0,677	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TGA	1,416	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Impact of GC content of coding genomes on codon usage (RSCU) of mammalian species

Codon	Number of points (species)	Pearson's r	R-Square (COD)	Slope value	Standard error of slope analysis	Adj. R-square of slope analysis
GCA (Ala)	96	-0,9540	0,9101	-6,7442	0,2186	0,9092
GCC (Ala)	96	0,9165	0,8399	7,5626	0,3405	0,8382
GCG (Ala)	96	0,9249	0,8555	6,8735	0,2914	0,8540
GCT (Ala)	96	-0,9187	0,8440	-7,6837	0,3407	0,8424
AGA (Arg)	96	-0,9504	0,9033	-7,4449	0,2513	0,9022
AGG (Arg)	96	-0,5135	0,2637	-2,2483	0,3875	0,2558
CGA (Arg)	96	-0,8339	0,6954	-3,1243	0,2133	0,6921
CGC (Arg)	96	0,8586	0,7372	7,4179	0,4568	0,7344
CGG (Arg)	96	0,9270	0,8593	8,2658	0,3449	0,8578
CGT (Arg)	96	-0,8524	0,7266	-2,9289	0,1853	0,7237
AAC (Asn)	96	0,7319	0,5357	3,3086	0,3177	0,5308
AAT (Asn)	96	-0,7319	0,5357	-3,3086	0,3177	0,5308
GAC (Asp)	96	0,8756	0,7667	4,2804	0,2436	0,7642
GAT (Asp)	96	-0,8756	0,7667	-4,2804	0,2436	0,7642
TGC (Cys)	96	0,9438	0,8907	4,4568	0,1610	0,8895
TGT (Cys)	96	-0,9438	0,8907	-4,4568	0,1610	0,8895
CAA (Gln)	96	-0,9006	0,8110	-2,7653	0,1377	0,8090
CAG (Gln)	96	0,9006	0,8110	2,7653	0,1377	0,8090
GAA (Glu)	96	-0,8659	0,7497	-2,8998	0,1728	0,7470
GAG (Glu)	96	0,8659	0,7497	2,8998	0,1728	0,7470
GGA (Gly)	96	-0,9588	0,9193	-5,4366	0,1661	0,9185
GGC (Gly)	96	0,9466	0,8960	6,8201	0,2397	0,8949
GGG (Gly)	96	0,7758	0,6019	3,0929	0,2594	0,5977
GGT (Gly)	96	-0,9137	0,8349	-4,4586	0,2045	0,8332
CAC (His)	96	0,9307	0,8662	5,2582	0,2131	0,8648
CAT (His)	96	-0,9307	0,8662	-5,2582	0,2131	0,8648
ATA (Ile)	96	-0,7112	0,5058	-1,6556	0,1688	0,5006
ATC (Ile)	96	0,7873	0,6198	5,0612	0,4089	0,6158
ATT (Ile)	96	-0,7806	0,6093	-3,4800	0,2874	0,6051
CTA (Leu)	96	-0,9140	0,8354	-3,9660	0,1816	0,8337
CTC (Leu)	96	0,8205	0,6732	3,4253	0,2462	0,6697
CTG (Leu)	96	0,8985	0,8074	10,1234	0,5100	0,8053
CTT (Leu)	96	-0,9161	0,8392	-4,6919	0,2118	0,8375
TTA (Leu)	96	-0,5185	0,2688	-1,6036	0,2728	0,2611
TTG (Leu)	96	-0,9196	0,8456	-3,3150	0,1461	0,8440
AAA (Lys)	96	-0,5285	0,2793	-1,7695	0,2932	0,2716
AAG (Lys)	96	0,5285	0,2793	1,7695	0,2932	0,2716
ATG (Met)	96	--	--	0,0000	0,0000	--
TTC (Phe)	96	0,8159	0,6657	3,2837	0,2400	0,6622
TTT (Phe)	96	-0,8159	0,6657	-3,2837	0,2400	0,6622
CCA (Pro)	96	-0,9560	0,9139	-8,1839	0,2590	0,9130
CCC (Pro)	96	0,9011	0,8120	7,7645	0,3854	0,8100
CCG (Pro)	96	0,9410	0,8856	8,0958	0,3002	0,8844
CCT (Pro)	96	-0,9261	0,8577	-7,6973	0,3234	0,8562
AGC (Ser)	96	0,9500	0,9024	5,7573	0,1953	0,9014
AGT (Ser)	96	-0,9412	0,8859	-4,1270	0,1528	0,8847
TCA (Ser)	96	-0,9170	0,8409	-5,2816	0,2370	0,8392
TCC (Ser)	96	0,8660	0,7500	4,5450	0,2707	0,7473
TCG (Ser)	96	0,9344	0,8731	5,2265	0,2055	0,8718
TCT (Ser)	96	-0,9567	0,9153	-6,1333	0,1924	0,9144
ACA (Thr)	96	-0,9276	0,8605	-7,1899	0,2986	0,8590
ACC (Thr)	96	0,9081	0,8247	5,1141	0,2432	0,8228
ACG (Thr)	96	0,9248	0,8553	7,8065	0,3312	0,8538
ACT (Thr)	96	-0,9489	0,9005	-5,7855	0,1984	0,8994
TGG (Trp)	96	--	--	0,0000	0,0000	--
TAC (Tyr)	96	0,8668	0,7514	4,4135	0,2618	0,7488
TAT (Tyr)	96	-0,8668	0,7514	-4,4135	0,2618	0,7488
GTA (Val)	96	-0,9106	0,8292	-3,6420	0,1705	0,8273
GTC (Val)	96	0,6835	0,4671	2,2480	0,2476	0,4615
GTG (Val)	96	0,8409	0,7071	4,8046	0,3190	0,7039
GTT (Val)	96	-0,8361	0,6990	-3,2479	0,2198	0,6958
TAA (Stop)	96	-0,7435	0,5527	-2,8130	0,2424	0,5486
TAG (Stop)	96	0,3356	0,1126	0,5487	0,1475	0,1045
TGA (Stop)	96	0,7982	0,6371	2,2736	0,1644	0,6337

Correlation between changes in codon usage and lifespan in rodent species

Codon	Number of points (species)	Pearson's r	R-Square (COD)	Slope value	Standard error of slope analysis	Adj. R-square of slope analysis
GCA (Ala)	19	0,4012	0,1610	0,0010	0,0006	0,1116
GCC (Ala)	19	0,2447	0,0599	0,0010	0,0010	0,0046
GCG (Ala)	19	-0,1078	0,0116	-0,0001	0,0002	-0,0465
GCT (Ala)	19	-0,6105	0,3727	-0,0020	0,0006	0,3358
AGA (Arg)	19	-0,5877	0,3454	-0,0023	0,0008	0,3069
AGG (Arg)	19	-0,3852	0,1484	-0,0014	0,0008	0,0983
CGA (Arg)	19	-0,6096	0,3716	-0,0013	0,0004	0,3347
CGC (Arg)	19	0,6438	0,4145	0,0037	0,0011	0,3801
CGG (Arg)	19	0,6151	0,3783	0,0023	0,0007	0,3417
CGT (Arg)	19	-0,6007	0,3608	-0,0012	0,0004	0,3232
AAC (Asn)	19	-0,7867	0,6189	-0,0032	0,0006	0,5964
AAT (Asn)	19	0,7867	0,6189	0,0032	0,0006	0,5964
GAC (Asp)	19	-0,6639	0,4407	-0,0016	0,0004	0,4078
GAT (Asp)	19	0,6639	0,4407	0,0016	0,0004	0,4078
TGC (Cys)	19	0,5259	0,2766	0,0010	0,0004	0,2340
TGT (Cys)	19	-0,5259	0,2766	-0,0010	0,0004	0,2340
CAA (Gln)	19	0,1447	0,0209	0,0002	0,0003	-0,0367
CAG (Gln)	19	-0,1447	0,0209	-0,0002	0,0003	-0,0367
GAA (Glu)	19	0,3372	0,1137	0,0005	0,0003	0,0616
GAG (Glu)	19	-0,3372	0,1137	-0,0005	0,0003	0,0616
GGA (Gly)	19	-0,7540	0,5685	-0,0014	0,0003	0,5431
GGC (Gly)	19	0,4576	0,2094	0,0009	0,0004	0,1629
GGG (Gly)	19	0,7575	0,5737	0,0016	0,0003	0,5487
GGT (Gly)	19	-0,4979	0,2479	-0,0009	0,0004	0,2037
CAC (His)	19	-0,0950	0,0090	-0,0001	0,0004	-0,0493
CAT (His)	19	0,0950	0,0090	0,0001	0,0004	-0,0493
ATA (Ile)	19	0,3625	0,1314	0,0004	0,0003	0,0803
ATC (Ile)	19	-0,7885	0,6217	-0,0027	0,0005	0,5994
ATT (Ile)	19	0,7590	0,5760	0,0023	0,0005	0,5511
CTA (Leu)	19	-0,6087	0,3705	-0,0010	0,0003	0,3335
CTC (Leu)	19	-0,7331	0,5375	-0,0019	0,0004	0,5103
CTG (Leu)	19	0,5497	0,3021	0,0019	0,0007	0,2611
CTT (Leu)	19	-0,1865	0,0348	-0,0002	0,0003	-0,0220
TTA (Leu)	19	0,6201	0,3845	0,0014	0,0004	0,3483
TTG (Leu)	19	-0,3277	0,1074	-0,0005	0,0003	0,0549
AAA (Lys)	19	0,7360	0,5417	0,0020	0,0004	0,5147
AAG (Lys)	19	-0,7360	0,5417	-0,0020	0,0004	0,5147
ATG (Met)	19	--	--	0,0000	0,0000	--
TTC (Phe)	19	-0,7530	0,5670	-0,0014	0,0003	0,5416
TTT (Phe)	19	0,7530	0,5670	0,0014	0,0003	0,5416
CCA (Pro)	19	-0,0461	0,0021	-0,0001	0,0004	-0,0566
CCC (Pro)	19	0,4932	0,2432	0,0022	0,0009	0,1987
CCG (Pro)	19	-0,4436	0,1968	-0,0009	0,0004	0,1495
CCT (Pro)	19	-0,3885	0,1509	-0,0011	0,0006	0,1010
AGC (Ser)	19	0,0670	0,0045	0,0002	0,0006	-0,0541
AGT (Ser)	19	0,5532	0,3060	0,0009	0,0003	0,2652
TCA (Ser)	19	0,7124	0,5075	0,0013	0,0003	0,4785
TCC (Ser)	19	-0,0776	0,0060	-0,0002	0,0005	-0,0524
TCG (Ser)	19	-0,5724	0,3277	-0,0008	0,0003	0,2881
TCT (Ser)	19	-0,6309	0,3980	-0,0009	0,0003	0,3626
ACA (Thr)	19	0,0784	0,0062	0,0002	0,0007	-0,0523
ACC (Thr)	19	0,0186	0,0003	0,0001	0,0007	-0,0585
ACG (Thr)	19	-0,6549	0,4288	-0,0017	0,0005	0,3952
ACT (Thr)	19	0,6771	0,4585	0,0014	0,0004	0,4266
TGG (Trp)	19	--	--	0,0000	0,0000	--
		0,0000				
TAC (Tyr)	19	-0,7446	0,5544	-0,0014	0,0003	0,5282
TAT (Tyr)	19	0,7446	0,5544	0,0014	0,0003	0,5282
GTA (Val)	19	0,2893	0,0837	0,0003	0,0002	0,0298
GTC (Val)	19	-0,7723	0,5964	-0,0024	0,0005	0,5727
GTG (Val)	19	0,5407	0,2923	0,0016	0,0006	0,2507
GTT (Val)	19	0,0939	0,0088	0,0001	0,0002	-0,0495
TAA (Stop)	19	-0,1712	0,0293	-0,0004	0,0005	-0,0278
TAG (Stop)	19	-0,1103	0,0122	-0,0001	0,0003	-0,0459
TGA (Stop)	19	0,2793	0,0780	0,0005	0,0004	0,0238

Correlation between changes in codon usage and lifespan in mammalian species

Codon	Number of points (species)	Pearson's r	R-Square (COD)	Slope value	Standard error of slope analysis	Adj. R-square of slope analysis
GCA (Ala)	96	-0,0460	0,0021	0,0000	0,0001	-0,0085
GCC (Ala)	96	0,2187	0,0478	0,0003	0,0001	0,0377
GCG (Ala)	96	0,2218	0,0492	0,0002	0,0001	0,0391
GCT (Ala)	96	-0,3779	0,1428	-0,0005	0,0001	0,1337
AGA (Arg)	96	0,0183	0,0003	0,0000	0,0001	-0,0103
AGG (Arg)	96	-0,1351	0,0182	-0,0002	0,0001	0,0078
CGA (Arg)	96	-0,4051	0,1641	-0,0003	0,0001	0,1552
CGC (Arg)	96	0,0396	0,0016	0,0001	0,0002	-0,0091
CGG (Arg)	96	0,3681	0,1355	0,0005	0,0001	0,1263
CGT (Arg)	96	-0,1258	0,0158	-0,0001	0,0001	0,0054
AAC (Asn)	96	-0,4419	0,1953	-0,0005	0,0001	0,1867
AAT (Asn)	96	0,4419	0,1953	0,0005	0,0001	0,1867
GAC (Asp)	96	-0,5123	0,2625	-0,0005	0,0001	0,2546
GAT (Asp)	96	0,5123	0,2625	0,0005	0,0001	0,2546
TGC (Cys)	96	0,1326	0,0176	0,0001	0,0001	0,0071
TGT (Cys)	96	-0,1326	0,0176	-0,0001	0,0001	0,0071
CAA (Gln)	96	0,2191	0,0480	0,0001	0,0001	0,0379
CAG (Gln)	96	-0,2191	0,0480	-0,0001	0,0001	0,0379
GAA (Glu)	96	0,3976	0,1581	0,0003	0,0001	0,1491
GAG (Glu)	96	-0,3976	0,1581	-0,0003	0,0001	0,1491
GGA (Gly)	96	-0,0921	0,0085	-0,0001	0,0001	-0,0021
GGC (Gly)	96	-0,0711	0,0051	-0,0001	0,0001	-0,0055
GGG (Gly)	96	0,4099	0,1680	0,0004	0,0001	0,1592
GGT (Gly)	96	-0,3393	0,1151	-0,0003	0,0001	0,1057
CAC (His)	96	-0,2703	0,0731	-0,0002	0,0001	0,0632
CAT (His)	96	0,2703	0,0731	0,0002	0,0001	0,0632
ATA (Ile)	96	0,4243	0,1801	0,0003	0,0001	0,1713
ATC (Ile)	96	-0,5485	0,3008	-0,0008	0,0001	0,2934
ATT (Ile)	96	0,5407	0,2924	0,0006	0,0001	0,2848
CTA (Leu)	96	-0,2806	0,0787	-0,0002	0,0001	0,0689
CTC (Leu)	96	-0,0848	0,0072	-0,0001	0,0001	-0,0034
CTG (Leu)	96	-0,3447	0,1188	-0,0007	0,0002	0,1094
CTT (Leu)	96	0,4104	0,1684	0,0003	0,0001	0,1596
TTA (Leu)	96	0,5464	0,2986	0,0006	0,0001	0,2911
TTG (Leu)	96	-0,0225	0,0005	0,0000	0,0001	-0,0101
AAA (Lys)	96	0,5412	0,2929	0,0006	0,0001	0,2854
AAG (Lys)	96	-0,5412	0,2929	-0,0006	0,0001	0,2854
ATG (Met)	96	--	--	0,0000	0,0000	--
TTC (Phe)	96	-0,5994	0,3593	-0,0005	0,0001	0,3525
TTT (Phe)	96	0,5994	0,3593	0,0005	0,0001	0,3525
CCA (Pro)	96	-0,2013	0,0405	-0,0002	0,0001	0,0303
CCC (Pro)	96	0,2087	0,0435	0,0003	0,0001	0,0334
CCG (Pro)	96	0,3283	0,1078	0,0004	0,0001	0,0983
CCT (Pro)	96	-0,4139	0,1713	-0,0005	0,0001	0,1625
AGC (Ser)	96	-0,0639	0,0041	0,0000	0,0001	-0,0065
AGT (Ser)	96	-0,0166	0,0003	0,0000	0,0001	-0,0104
TCA (Ser)	96	0,5203	0,2707	0,0005	0,0001	0,2629
TCC (Ser)	96	-0,3085	0,0952	-0,0003	0,0001	0,0856
TCG (Ser)	96	0,2017	0,0407	0,0002	0,0001	0,0305
TCT (Ser)	96	-0,2865	0,0821	-0,0002	0,0001	0,0723
ACA (Thr)	96	-0,2598	0,0675	-0,0003	0,0001	0,0576
ACC (Thr)	96	-0,0528	0,0028	0,0000	0,0001	-0,0078
ACG (Thr)	96	0,2332	0,0544	0,0003	0,0001	0,0443
ACT (Thr)	96	0,1158	0,0134	0,0001	0,0001	0,0029
TGG (Trp)	96	--	--	0,0000	0,0000	--
TAC (Tyr)	96	-0,4747	0,2253	-0,0005	0,0001	0,2171
TAT (Tyr)	96	0,4747	0,2253	0,0005	0,0001	0,2171
GTA (Val)	96	0,2119	0,0449	0,0001	0,0001	0,0348
GTC (Val)	96	-0,2796	0,0782	-0,0003	0,0001	0,0684
GTG (Val)	96	-0,3682	0,1356	-0,0004	0,0001	0,1264
GTT (Val)	96	0,6085	0,3703	0,0005	0,0001	0,3636
TAA (Stop)	96	0,43333638	0,18778	4,53E-04	9,72E-05	0,17914
TAG (Stop)	96	-0,4279569	0,183147	-2,72E-04	5,92E-05	0,174457
TGA (Stop)	96	-0,25422	0,06463	-1,78E-04	6,98E-05	0,054678

GC content of the coding genomes and relative synonymous codon usage (RSCU) of 96 mammalian species with known lifespan

Notes: The colors reflect the RSCU values of synonymous codons: green indicates the least preferred codon, red the most preferred, with intermediate values shown as a gradient from green to red via yellow.

Lifespan: Maximum lifespan in years according to the AnAge database. https://genomics.senescence.info/species/index.html