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Original Communication

Comparison of circulating concentrations of glucose in vertebrate and invertebrate taxa: evolutionary and physiological implications

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ABSTRACT

To allow analysis of the variation in circulating concentrations of glucose, a database was assembled of published concentrations of glucose in serum/ plasma of vertebrates and annelids, hemolymph of mollusks and arthropods, blood of annelids, and celomic fluid of echinoderms. Within major taxa, circulating concentrations of glucose are fairly consistent with coefficients of variation of 84.3% (mollusks), 66.5% (arthropods excluding the insects) and 64.0% (chordates/vertebrates). There were lower coefficients of variation for circulating concentrations of glucose within some vertebrate classes, namely Aves (23.7%), Mammalia (33.9%) and Actinopterygii (46.5%). Circulating concentrations of glucose are very low in annelids and echinoderms [< 0.3 mM], low in mollusks [0.52 ± (n = 8 species) stardard error of the mean (S.E.M.) 0.16 mM] and arthropods excluding insects [1.00 ± (33 species) 0.12 mM] but markedly higher in insects [7.2 ± (5) 2.4 mM] and vertebrates [9.4 ± (626) 0.24 mM]. Within the vertebrates, circulating concentrations of glucose are relatively low in species in the Superclass Cyclostomata [2.6 ± (6) S.E.M. 0.59 mM], in the Super-order Batoidea in the Class Chondrichthyes [1.9 ± (4) 0.20 mM], in the Class Actinopterygii [4.3 ± (91) 0.21 mM], in the Class Sarcopterygii [3.1 ± (4) 1.12 mM], in the Class Amphibia [2.8 ± (11) 0.66 mM], Class Reptilia excluding Family Lacertidae and families in Sub-order Iguania [4.3 ± (92) 0.21 mM] and within Class Mammalia, Prototheria [3.3 ± (2) 0.85 mM], Super-order Afrotheria [4.6 ± (3) 0.53 mM] and Super-order Xenarthra [3.0 ± (4) 0.75 mM]. There is evidence of multiple events each resulting in increases in the set-point for circulating concentrations of glucose. There are elevated concentrations of glucose in the mammals in Super-orders Laurasiatheria [7.6 ± (96) 0.22 mM] and Euarchontoglires [7.2 ± (31) 0.52 mM] and in reptiles of Sub-order Iguania [9.6 ± (19) 0.77 mM] and the Family Lacertidae [11.0 ± (6) 1.15 mM] together with even larger increases in birds in the Super-order Paleognathae in Class Aves [10.9 + (4) 0.84 mM] with a further increase in birds in the Neognathae [16.0 + (226) 0.25 mM].

KEYWORDS: glucose, vertebrates, invertebrates, evolution

INTRODUCTION

Glucose is the product of photosynthesis and is thought to be the most abundant organic molecule on the planet in the predominantly polymeric form (reviewed: [1]). Carbohydrate metabolic pathways exhibit commonality across Archaea, Bacteria and Eukarya [2]. Moreover, carbohydrate metabolism is generally assumed to be similar or identical across both invertebrate vertebrate taxa (reviewed e.g. in birds: [3-5]; fish: [6]; mammals: [7-8]). Recently, drosophila has been proposed as a useful model for studying carbohydrate metabolism [9]. The present communication comprehensively examines the relationship between circulating concentrations of

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glucose and taxa/evolutionary relationships in both vertebrate and invertebrate taxa.

Movement of glucose into tissues depends on the circulating concentration of glucose together with the presence, number and affinity of glucose transporters. The glucose transporters (GLUT) 1, 2 and 3 but not 4 are expressed in birds (e.g. chicken: [10]; mourning dove: [11]). While birds lack the insulin dependant GLUT 4, insulin does influence circulating concentrations of glucose (reviewed: [4-5]), glucose uptake by muscle [12] and avian tissues with effects, for instance, on muscle phosphofructokinase-1 [13]. Glucose transporters 1-4 have been identified in lower vertebrates [14-19]. Glucose transporters are also present in marine invertebrates (reviewed: [1]).

MATERIALS AND METHODS

Databases

A series of databases were assembled for circulating concentrations of glucose using the published or calculated mean for the species based on rigorous and systematic series of searches of the literature. The databases for circulating concentrations of glucose are shown for the following: invertebrates (Supplementary Table A), mammals (Supplementary Table B), birds [5], reptiles (Supplementary Table C), and amphibians and fish (Supplementary Table D).

Statistics

Data were analyzed by taxa using one-way analysis of variance, with mean separated by Tukey's range test or for comparisons between two taxa by Student's t test.

RESULTS

Table 1 summarizes glucose concentrations in either hemolymph or blood in invertebrate species by major taxa. Circulating concentrations of glucose were detectable in annelid, mollusk and arthropod species, albeit at low levels (< 1.5 mM) and in one nematode (see Supplementary Table A). Blood glucose concentrations were lower ($p < 0.05$) in

Table 1. Comparison of concentrations of glucose in hemolymph and blood in invertebrate species[‡] by major taxa.

Taxa	Mean circulating glucose mM (mmoles l^{-1}) ± S.E.M.
Super-phylum Protostomia	
Phylum Annelida including Sipunculan species[†]	0.28 ± (5) 0.05[a]
Phylum Mollusca	0.52 ± (8) 0.16[a]
Phylum Arthropoda excluding insects	1.00 ± (34) 0.10[b]
Within Phylum Arthropoda	
Sub-phylum Chelicerata	1.05 ± (16) 0.17
Sub-phylum Crustacea[††]	0.94 ± (18) 0.18
Sub-phylum Hexapoda Class Insecta[†††]	7.2 ± 2.4 (5)
Within Bilateria	
Super-phylum Protostomia excluding insects	0.84 ± (46) 0.24[a]
Super-phylum *Deuterostomia* (vertebrates)	9.4 ± (626) 0.24[b]

[‡]Data on individual species is shown in Supplementary Table A.
[a,b]Different superscript letters indicate difference $p < 0.05$.
[†]Based on [20, 21].
[††]Excluding juvenile Pacific shrimp as juveniles rather than adults and as Pacific shrimp mean glucose concentration is greater than Crustacean mean +2 standard deviations (S.D.).
[†††]Employs concentrations in fasted insects, where available.

annelid and mollusk species than in arthropods (excluding insects) (Table 1). Within the Arthropods, there was no difference in the concentration of glucose in the hemolymph of species within the Sub-phyla Crustacea and Chelicerata (Table 1). In contrast, fasting hemolymph concentrations of glucose were 7.2 fold higher ($p < 0.001$) in insect species than hemolymph concentrations of glucose of other arthropods. The mean of concentrations of glucose in hemolymph and blood from Protostome species (excluding insects) was 8.9% that of the serum/ plasma concentrations of glucose in Deuterostomes (namely vertebrates) (Table 1).

Figure 1 summarizes the circulating concentrations of glucose in vertebrate taxa with data detailed in Tables 2 (vertebrate classes), 3 (mammals), 4 (birds), 5 (reptiles) and 6 (species in the Chondrichthyes). Circulating concentrations of glucose were predominantly relatively low in poikilothermic species – superclass Cyclostomata and classes Chondrichthyes, Actinopterygii, Sarcopterygii, Amphibia and Reptilia (Figure 1A and Table 2) and in some mammalian groups. Within the Eutherian mammals, circulating concentrations of glucose were approximately two fold high ($p < 0.01$) in the species within the Super-orders Laurasiatheria (e.g. carnivores, ungulates, bats, etc.) and Euarchontoglires (primates, rodents and rabbits) compared to more primitive Eutherian mammals, the Atlantogenata (Super-orders Afrotheria (e.g. elephants) and Xenarthra (e.g. armadillos and sloths)) (Figure 1B and Table 3). Within the Super-order Laurasiatheria, circulating concentrations of glucose were 47.5% higher ($p < 0.01$) within the Order Artiodactyla (e.g. cattle, deer) than in Order Perissodactyla (e.g. horses) (Table 3).

Within the Class Aves, circulating concentrations of glucose were 46.8% higher ($p < 0.001$) in the

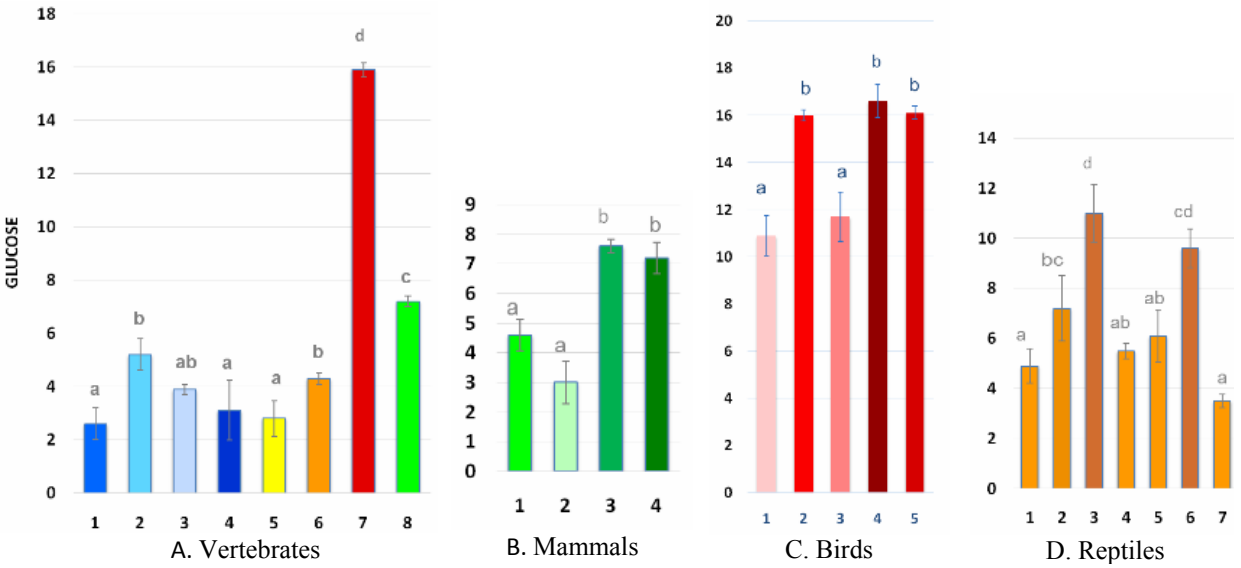

Figure 1. Comparison of circulating (serum/plasma) concentrations of glucose in vertebrate taxa. Mean in mM ± S.E.M. (vertical bars).
A. Vertebrates: 1. Superclass Cyclostomata; 2. Class Chondrichthyes; 3. Class Actinopterygii; 4. Class Sarcopterygii; 5. Class Amphibia; 6. Class Reptilia; 7. Class Aves; 8. Class Mammalia.
B. Mammalia: Within the Sub-class Theria and Branch Eutheria – 1. Super-order Afrotheria; 2. Super-order Xenarthra; 3. Super-order Laurasiatheria; 4. Super-order Euarchontoglires.
C. Aves: 1. Infra-class Palaeognathae; 2. Infra-class Neognathae; 3. Within the Infra-class Neognathae and Super-order Galloanserae Order Anseriformes; 4. Within the Infra-class Neognathae and Super-order Galloanserae Order Galliformes; 5. Within the Infra-class Neognathae Super-order Neoaves Clade Coronaves.
D. Reptilia: 1. Infra-order Gekkota; 2. Family Scincidae; 3. Family Lacertidae; 4. Family Teiidae; 5. Infra-order Anguimorpha; 6. Sub-order Iguania; 7. Sub-order Serpentes.
Different letters (a, b, c, d) indicate difference $p < 0.05$.

Table 2. Comparison of circulating concentrations of glucose in vertebrate species by major taxa[Δ].

Taxa	Plasma/serum Glucose (mmoles liter^{-1} or mM) ± (n = species) S.E.M.
Superclass Tetrapoda	
Class Mammalia	7.2 ± (148) 0.20[c]
Class Aves	15.9 ± (228) 0.25[d]
Class Reptilia[‡]	5.5 ± (117) 0.35[b‡]
Class Amphibia	2.8 ± 0.66 (11)[a]
Class Sarcopterygii	3.1 ± 1.12 (4)[a]
Class Actinopterygii	3.9 ± 0.19 (88)[ab]
Class Chondrichthyes	5.2 ± 0.59 (20)[b]
Superclass Cyclostomata	2.6 ± 0.59 (6)[a]

[Δ]Data on individual species is shown in Supplementary Tables B-D.
[a,b,c,d]Different superscript letters indicate difference $p < 0.05$.
[‡]Excluding Family Lacertidae and families in Sub-order Iguania plasma/serum glucose for Class Reptilia = 4.3 ± (92) 0.21.

Infra-class Neognathae (modern birds) than those in the Infra-class Palaeognathae (emus, ostriches, etc.). However, circulating concentrations of glucose were higher ($p < 0.01$) in the Infra-class Palaeognathae (emus, ostriches, etc.) compared to poikilothermic vertebrates (Tables 2 and 4). Within birds of Neognathae and the Super-order Galloanserae, circulating concentrations of glucose were 41.9% higher ($p < 0.001$) in the Order Galliformes than those in the Order Anseriformes (Figure 1C and Table 4). Within birds of Neognathae and the Super-order Neoaves, circulating concentrations of glucose were lower ($p < 0.05$) in the waterbirds (Gruiformes together with the "Waterbird radiation") (Table 4).

Within the Class Reptilia, circulating concentrations of glucose were similar in the major divisions (orders) (Table 5). However, circulating concentrations of glucose were elevated ($p < 0.01$) in two groups of Squamate reptiles, namely reptiles of Sub-order Iguania and the Family Lacertidae (Figure 1D and Table 5). Within the Classes Actinopterygii and Amphibia, there were no discernible evolutionary/ taxonomic relationship with circulating concentrations of glucose (data not shown). Within the Chondrichthyes, circulating concentrations of glucose were 3.2 fold higher in the Super-order Selachimorpha than in the Super-order Batoidea (Table 6).

Table 3. Comparison of circulating concentrations of glucose in mammalian species[‡] by major taxa.

Taxa[†]	Plasma/serum Glucose (mmoles liter^{-1} or mM) (n = species)
Within major clades	
Sub-class Prototheria	3.3 ± (2) 0.85
Sub-class Theria	7.2 ± (146) 0.20
Within Sub-class Theria	
Branch Marsupialia	5.9 ± (14) 0.39
Branch Eutheria	7.3 ± (132) 0.21
Within Branch Eutheria	
Branch Atlantogenata	
Super-order Afrotheria	4.6 ± (3) 0.53[a]
Super-order Xenarthra	3.0 ± (4) 0.75[a]
Branch Boreutheria	
Super-order Laurasiatheria	7.6 ± (95) 0.22[b]
Super-order Euarchontoglires	7.2 ± (31) 0.52[b]
Within Super-order Laurasiatheria	
Order Chiroptera	6.4 ± (7) 0.64[a]
Order Carnivora	7.1 ± (33) 0.34[ab]
Order Perissodactyla	5.9 ± (4) 0.65[a]
Order Artiodactyla	8.7 ± (43) 0.30[b]
Order Cetacea	6.9 ± (15) 0.33[ab]
Within Super-order Euarchontoglires	
Order Primates	6.3 ± (13) 0.61[a]
Order Rodentia	7.2 ± (15) 0.75[a]
Order Lagomorpha	11.5 ± (3) 1.40[b]

[‡]Data on individual species is shown in Supplementary Table B.
[†]Taxa based on [22, 23].
[a, b]Different superscript letters indicate difference $p < 0.05$.

DISCUSSION

Glucose is detectable in the hemolymph (arthropods and mollusks), blood/coelomic fluid (annelids), coelomic fluid (echinoderms) and blood serum/ plasma (vertebrates). Circulating concentrations of glucose are higher in arthropods than mollusks or annelids and much greater in chordates (vertebrates) than arthropods (Table 1). Circulating concentrations

Table 4. Comparison of circulating concentrations of glucose in avian species[‡] (excluding domesticated birds) by major taxa.

Taxa[†]	Plasma/serum glucose in mM or mM L^{-1} + S.E.M. (n = number of species)
Within Class Aves	
Infra-class Palaeognathae	10.9 ± 0.84 (4)[a]
Infra-class Neognathae	16.0 ± 0.25 (226)[b]
Within Super-order Galloanserae	
Order Anseriformes	11.7 ± 1.05 (15)[a]
Order Galliformes excluding chicken	16.6 ± 0.70 (18)[b]
Within Super-order Neoaves	
Metaves [Phoenicopteriformes, Phaethontiformes, Columbiformes and Apodiformes][‡]	15.0 ± 0.80 (16)
Coronaves[‡]	16.1 ± 0.28 (160)
Within Coronaves	
Order Charadririiformes	16.6 ± 0.52 (25)[b]
Landbird assemblage (Afroaves + Australaves)	17.2 ± 0.38 (85)[b]
Core Gruiformes/Waterbird radiation (together with Cuculidae, Otididae) (Ciconiiformes, Gaviformes, Pelicaniformes, Procellariiformes, Sphenisciformes)	14.0 ± 0.43 (50)[a]
Within Landbird assemblage	
Afroaves [Accipitriformes, Strigiformes, Trogiformes, Coraciiformes, Piciformes]	17.7 ± 0.47 (41)
Australaves [Passeriformes, Psittaciformes, Falconiformes]	16.7 ± 0.59 (44)

[‡]Data on individual species is shown in Supplementary table in [5].
[a,b,c,d]Different superscript letters indicate difference $p < 0.05$.
[†]Based on [24-26] and broadly consistent with the Tree of Life.

of glucose seem to be at a remarkedly consistent level across the Actinopterygii, Sarcopterygii, Amphibia and Reptilia (Family Lacertidae and families in Sub-order Iguania) together with some mammalian taxa (Sub-class Prototheria, Branch Marsupialia, Super-order Afrotheria and Super-order Xenarthra). Within the higher vertebrates, there appear to have been multiple, and seemly independent, shifts in the "set-point" for circulating concentrations of glucose. There appear to be five evolutionary events with increases in the circulating concentrations of glucose. These are the following:

1. In the Eutherian mammals, in the Super-orders Laurasiatheria and Euarchontoglires (Figure 1B and Table 2) representing the branch Boreutheria [23].
2. In birds in the Palaeognathae.
3. In modern birds, a further increase at about the time of the divergence of the Super-order Neoaves from the Galloanserae with the increase evident in the Neoaves and the Galliformes but not in Anseriformes (Figure 1C and Table 4).
4. In reptiles of Sub-order Iguania.
5. In reptiles of the Family Lacertidae.

Traditionally, reptiles of the order Squamata have been assigned based on morphology to two clades/ sub-orders: Iguania and Scleroglossa (including lizards in the Infra-order Gekkota plus families including Helodermatidae, Lacertidae, Scincidae, Teiidae, Varanidae together with snakes of the infra/sub-order Serpentes [30]. Genomic analysis has led to a refined understanding of reptilian

Table 5. Comparison of circulating concentrations of glucose in reptilian species[‡] by major taxa.

Taxa[†]	Plasma/serum Glucose (mmoles liter^{-1} or mM) (n = species)
Within major taxa	
Order Testudines	4.3 ± (28) 0.35
Order Crocodilia	4.8 ± (7) 0.48
Order Rhynchocephalia	3.8 (1)
Order Squamata	5.9 ± (82) 0.41[Δ]
Within Order Squamata	
Infra-order Gekkota	4.9 ± (4) 0.69[ab]
Family Scincidae	7.2 ± (4) 1.32[bc]
Family Lacertidae	11.0 ± (6) 1.15[d]
Family Teiidae	5.5 ± (2) 0.3[ab]
Infra-order Anguimorpha (Families Helodermatidae and Varanidae)	6.1 ± (6) 1.04[ab]
Sub-order Iguania	9.6 ± (19) 0.77[cd]
Sub-order Serpentes	3.5 ± (41) 0.27[a]
Alternative within Order Squamata[‡]	
Infra-order Gekkota (basal)	4.9 ± (4) 0.69[ab]
Infra-order Scincoidea (Family Scincidae)	7.2 ± (4) 1.32[bc]
Infra-order Laceroidea (Families Teiidae and Lacertidae)	9.6 ± (8) 1.23[c]
Sub-order Iguania	9.6 ± (19) 0.77[c]
Infra-order Anguimorpha (Helodermatidae and Varanidae)	6.1 ± (6) 1.04[ab]
Sub-order Serpentes	3.5 ± (41) 0.27[a]

[‡]Data on individual species is shown in Supplementary Table C.
[a,b,c,d]Different superscript letters indicate difference $p < 0.05$.
[Δ]Excluding Family Lacertidae and families in Sub-order Iguania 4.2 ± (57) 0.24 mM.
[†]Based on [21, 27-29] and broadly consistent with the Tree of Life.

Table 6. Comparison of circulating concentrations of glucose in species of Class Chondrichthyes by major taxa.

Taxa	Plasma/serum Glucose (mmoles liter^{-1} or mM) ± (n = species) S.E.M.
Super-order Batoidea	1.9 ± (4) 0.20[a]
Super-order Selachimorpha	6.1 ± (15) 0.59[b]

[a,b]Different superscript letters indicate difference $p < 0.05$.

evolution (e.g. [20, 21, 27-31]). There seems to be near unanimity for the following: gekkos being a basal group in the Squamata; Serpentia being clearly part of the order and separation among the Iguania, the Lacertoidea, the Anguimorpha and the Scincoidea (e.g. [21, 27, 28] and broadly with the Tree of Life).

In insects, concentrations of glucose in the hemolymph were much higher than in other arthropods. These elevated concentrations of glucose are similar to re-calculated data from very early studies, circulating concentrations of reducing sugars being high in leptidopteran insects (13.0 mM for the Drinker moth (*Cosmotriche potatoria*); 14.0 mM for the Goat moth (*Cossus ligniperda*); 4.2 mM for the Eyed hawk-moth (*Smerinthus ocellatus*)) but low in crustaceans (0.15 mM in European crayfish (*Astacus astacus*)) [32]. The increases in concentrations of glucose does not appear to be related to the diet of the insects. It is argued that elevated hemolymph concentrations of

glucose represent a shift in the "set-point" and thereby facilitate metabolic requirements of the nervous system and flight.

The mean of concentrations of glucose in hemolymph and blood from Deuterostome species (namely vertebrates) were much higher than in Protostome species (excluding insects) (Table 1). While there is little information on concentrations of glucose in body fluids of invertebrate chordates, there is overwhelming evidence of the presence of insulin, a major hormone controlling circulating concentrations of glucose [33-36].

It is questioned whether the increased circulating concentrations of glucose represent an evolutionary advantage. It is argued that increased circulating concentrations of glucose are linked to central nervous system functioning. There is a close relationship between circulating and intra-cerebral concentrations of glucose concentrations, with intra-cerebral concentrations of glucose elevated in hyperglycemia and markedly depressed in hypoglycemia and also ischemia [37].

Table 7 summarizes brain glucose utilization across multiple vertebrate species. In mammals, there is a very strong relationship ($R^2 = 0.99$) between brain glucose consumption and brain volume/mass in mammals with $\log_{10}$ glucose utilization = 0.86 $\log_{10}$ brain size (in cm^3) – 0.09 [54]. It is possible to compare the glucose utilization reported in representative birds, reptiles and amphibians with those of mammals using the above equation and assuming a brain density of 1.0 [55]. Brain glucose utilization is somewhat lower in birds and much reduced in reptiles and amphibians as can be seen in the following:

- Bird brain utilization of glucose - 39% of mammals of the same brain size (chickens: 46%; pigeon: 33%, calculated from data in Table 7).
- Reptile brain utilization of glucose - 12.5% of mammals of the same brain size (calculated from data in Table 7).
- Amphibian brain utilization of glucose - 7.1% of mammals of the same brain size (calculated from data in Table 7).

It might be argued that the lower brain glucose utilization in reptiles and amphibians reflects the

Table 7. Comparison of brain glucose utilization in different vertebrate species.

Species	Brain glucose uptake/utilization μmol min^{-1} g^{-1}	Brain weight (g)	Reference
Mouse (*Mus musculus*)	0.89; 0.650	0.4	[38], [39]
Thirteen-lined ground Squirrel (*Spermophilus tridecemlineatus*)	0.77	7.6	[40]
Rabbit (*Oryctolagus cuniculus*)	0.69	12.1	[41]
Cat (*Felis silvestris*)	0.69	25.6	[42]
Rat (*Rattus norvegicus*)	0.62	2	[43]
Monkey (*Macaca*)	0.36	95	[44]
Sheep (*Ovis aries*)	0.35	175	[45]
Goat (*Capra aegagrus*)	0.35	115	[46], [47]
Baboon (*Papio anubis*)	0.44	137	[48]
Human (*Homo sapiens*)	0.34‡; 0.21	1320	[49], [50]
Chicken (*Gallus gallus*)	0.31	4 estimated	Calculated from data of Tokushima [12].
Mourning dove (*Zenaidura macroura*)	0.24†	2 estimated	Calculated from [51].
Garter snake (*Thamnophis sirtalis*)	0.14	0.1	Calculated from data of [52] and mean plasma glucose concentration of Colubrid snakes (Supplementary Table D).
Western Toad (*Bufo boreas*)	0.07	0.24	[53]

‡Awake cf. 0.24 μmol min^{-1} g^{-1} during sleep [49].
†Determined as glucose uptake.

lower body temperature/metabolic rate. That is not the case in birds where body temperatures are higher than those in mammals. It is presumed that the brain glucose utilization depends on the circulating concentration of glucose and the transport of glucose. Glucose transporters, GLUT 1, 2 and 3 are expressed in the bird brain (e.g. House sparrow (*Passerdomesticus*): [11]; Red-throated hummingbird (*Archilochus colubris*): [56]). The GLUT 1 transporter is a critical glucose transporter at the blood brain barrier (reviewed: [37]).

CONCLUSIONS

The present paper clearly demonstrates different circulating concentrations of glucose in different taxa. There is a higher blood concentration of glucose with increasing metabolic rate in vertebrates [57]. There is a negative relationship between blood concentrations of glucose and body weight in mammals [58] and birds [3]. What is not known is whether there are relationships between circulating concentrations of glucose and either physiological functions across taxa or ecological parameters.

ACKNOWLEDGMENTS

The helpful discussions with colleagues are gratefully acknowledged.

CONFLICT OF INTEREST STATEMENT

There were no conflicts of interest.

SUPPLEMENTARY MATERIAL

Supplementary Table A. Circulating concentrations of glucose in invertebrate species.

Species and taxa	Plasma/serum Glucose (mmoles liter^{-1} or mM) ± (n = species) S.E.M.	Other notes	Reference
Phylum Nematoda			
Giant roundworm (*Ascaris lumbricoides*)	3.0	Estimated from [59] and assuming hemolymph contains 2% solid.	
Super-phylum Protostomia			
Phylum Annelida			
Class Polychaeta			
Ornate worm (*Amphitrite ornate*)	0.48		[60]
Class Clitellata			
Earthworm (*Lumbricus terrestris*)	< 0.2	Glucose cleared rapidly from blood after challenge with $t_{1/2}$ < 60 minutes.	[61]
Freshwater leech (*Poecilobdella viridis*)	< 0.2		[62]
Phylum Sipuncula			
Peanut worm (*Phascolopsis gouldii*)	0.26		[60]
Sipunculan worm (*Themiste dyscrita*)	0.27	High and releasable glycogen in hemocytes.	[63]
Phylum Arthropoda			
Sub-phylum Helapoda			
Class Insecta			
Silkworm larva (*Bombyx mori*)	26.1	Glucose fasted 7.2 mM	[64]
Fruit fly (*Drosophila melanogaster*)	3.2	Trehalose ~6.5 mM	[65]

Supplementary Table A continued..

	Honeybee (*Apis mellifera*)	86.7; 0.56	Trehalose 112 mM Fructose 60 mM	[66] [67]
	Honeybee (*Apis mellifera*)	33 (fasted 7 hours = 5.5)	Trehalose 96 (fasted 7 hours = 18) Fructose 44 mM (fasted 7 hours = 11 mM)	[68]
	American cockroach (*Periplaneta americana*)	5.6; 2.4 3.6 Mean 3.9	Trehalose 66.7 mM	[69] [70] [66]
	Nectar-feeding ant (*Camponotus rufipes*)	16.3	Trehalose 94 mM Fructose 2.8 mM	[71]
Sub-phylum Chelicerata				
Class Arachnida				
	Banded garden spider (*Aranea trifasciata*)	2.39		[72]
	Cat-faced spider (*Araneus gemma*)	2.0		[72]
	Chilean rose spider (*Grammostola rosea*)	0.97		[73]
	Curly haired tarantula spider (*Brachypelma albopilosum*)	0.55	Concentrations increase during development and are higher in males than females.	[74]
	Tarantula (*Eurypelma californicum*)	0.70		[75]
	Giant crab spider (*Heteropoda venatoria*)	0.80		[76]
	Goliath bird-eater spider (*Theraphosa blondi*)	1.03		[73]
	Hackled mesh weaver (*Callobius bennetti*)	0.46		[76]
	Lycosa avida	1.08		[77]
	Lycosa frondicolo	1.65		[77]
	Pardosa distincta	0.69		[77]
	Pardosa lapidicina	0.43		[77]
	Pardosa milvina	0.76		[77]
	Pirata insularis	0.41		[77]
	Pisaurina mira	2.19		[77]
Class Merostomata				
	American horseshoe crab (*Limulus polyphemus*)	0.63		[78]
Sub-phylum Crustacea				
Class Malacostraca				
Order Decapoda				
Family Astacidae				

Supplementary Table A continued..

	Crayfish (*Astacus leptodactylus*)	0.22		[79]
Family Cambaridae				
	Crayfish (*Procambarus clarkii*)	0.67		[80]
Family Cancridae				
	Edible crab (*Cancer pagurus*)	0.83		[81]
Family Galatheidae				
	Squat lobster (*Munida rugosa*)	0.097		[82]
Family Nephropidae				
	American lobster (*Homarus americanus*)	1.1	Lactate 607 ± 14.8 mg/ml.	[83]
Family Ocypodidae				
	Fiddler crab (*Uca pugilator*)	0.26		[84]
Family Palaemonidae				
	Prawn (*Palaemon serratus*)	1.5		[85]
Family Palinuridae				
	Rock lobster (*Jasus edwardsii*)	0.63	Increased to 1.87 following feeding with glucose.	[86]
	Caribbean spiny lobster (*Panulirus argus*)	1.67		[87]
	Spiny lobster (*Panulirus interruptus*)	0.64	Increased with hypoxia; Lactate 0.1 to 0.29 mg/ml (1.1-3.2 mM).	[88]
Family Parathelphusidae				
	Rice field crab (*Oziotelphusa senex*)	0.49; 0.44		[89] [90]
Family Penaeidae				
	Pacific blue shrimp (*Litopenaeus stylirostris* or *Penaeus stylirostris*)	0.6		[91]
	White shrimp (*Litopenaeus setiferus)*	0.87; 0.80		[92] [93]
	Whiteleg or Pacific shrimp (*Litopenaeus vannamei*)	Juveniles 3.1 Juveniles 6.7	1.7-4.3 during phases of molt.	[94] [95]
	Pink shrimp (*Farfantepenaeus duorarum*)	1.6		[96]
Family Portunidae				
	Chesapeake blue crab (*Callinectes sapidus*)	1.64	Glucose concentrations decreased by infection with pathogens.	[97]
	Swimming crab (*Liocarcinus depurator*)	0.14		[81]
Family Squillidae				
	Mantis shrimp (*Squilla mantis*)	0.9		[98]

Supplementary Table A continued..

Sub-phylum Myriapola				
Class Chilopoda				
	New Zealand centipede (*Cormocephalus rubriceps*)	0.33	13 mM for hemolymph carbohydrate.	[99]
Class Gastropoda				
	Taiwan abalone (*Haliotis diversicolor*)	0.12		[100]
	A freshwater snail (*Biomphalaria glabrata*)	0.7; 2.2		[101] [102]
	Garden snail (*Helix aspersa*)	0.56		[103]
	California sea hare or California sea slug (*Aplysia californica*)	0.13		[104]
Class Bivalvia				
	Eastern elliptio (*Elliptio complanata*)	0.14		Estimated from [105]
	Painter's mussel (*Unio pictorum)*	0.65		[106]
Class Cephalopoda				
	Common octopus (*Octopus vulgaris*)	27	Mannose 0.3	[107]
	Mexican four-eyed octopus (*Octopus maya*)	0.5		[108]
Super-phylum Deuterostomia				
Phylum Echinodermata				
	Forbes sea star (*Asterias forbesi*)‡	0.04		[109]

‡Coelomic fluid.

Supplementary Table B. Circulating concentrations of glucose in mammalian species.

Classification	Species	Glucose in mM	Reference
Sub-class Prototheria			
Order Monotremata			
	Platypus (*Ornithorynchus anatinus*)	4.3	Mean: [110] and [111]
	Short-beaked echidna (*Tachyglossus aculeatus*)	4.2	Mean: [112] and [113]
Sub-class Theria			
Infra-class Marsupialia			
Order Dasyuromorphia			
Family Dasyuridae			
	Chuditch (*Dasyurus geoffroii*)	6.2	[114]
Order Didelphimorphia			
Family Didelphidae			
	American woolly opossum (*Caluromys derbianus)*	5.0	[115]
	Common opossum (*Didelphis marsupialis*)	5.1	[116]
	Gray short-tailed opossum (*Monodelphis domestica*)	5.3	[117]

Supplementary Table B continued..

	Virginia opossum (*Didelphis marsupialis*)	4.8	[118]
Order Diprotodontia			
Family Macropodidae			
	Common wallaroo (*Macropus robustus*)	4.8	[119]
	Red kangaroo (*Macropus rufus*)	4.7	[120]
	Tammar wallaby (*Macropus eugenii*)	5.2	[121]
	Quokka (*Setonix brachyurus*)	4.3	Mean: [122] and [123]
	Tasmanian pademelon (*Thylogale billardierii*)	4.5	[124]
	Brush tailed rock wallaby (*Petrogale penicillata*)	6.2	[125]
Family Petauridae			
	Sugar glider (*Petaurus breviceps*)	4.2	[126]
Family Phalangeridae			
	Common brush tail possum (*Trichosurus vulpecula*)	7.62	Mean: [127] and [128]
	Mountain brush tail possum (*Trichosuruscaninus ogilby*)	6.8	[129]
Family Potoroidae			
	Gilbert's potoroo or rat kangaroo (*Potorous gilbertii*)	9.1	[130]
Family Vombatiformes (Wombats)			
	Hairy-nosed wombats (*Lasiorhinus latifrons*)	6.2	[131]
	Northern hairy-nosed wombats (*Lasiorhinus krefftii*)	8.0	[132]
Infra-class Eutheria			
Super-order Afrotheria			
Order Afrosoricida			
	Lesser hedgehog tenrec (*Echinops telfairi*)	4.4	[133]
Order Hyracoidea			
	Rock hyrax (*Procavia capensis*)	3.7	[134]
Order Proboscidea			
Family Elephantidae			
	African elephant (*Loxadonta africana*)	4.6	[135]
	Asian/Indian elephant (*Elephas maximus*)	5.55	Mean: [136] and [137]
Order Sirenia			
	Amazonian manatee (*Trichechus inunguis*)	2.4	Mean: [138] and [139]
	Dugong (*Dugong dugon*)	6.9	[140]
	West Indian manatee (*Trichechus manatus*)	4.55	Mean: [141] and [142]
Order Tubulidenta			
	Aardvark (*Orycteropus afer*)	5.1	[143]
Super-order Xenarthra			
Order Cingulata			
	Three-banded armadillo (*Tolypeutes matacus*)	4.8	[144]
	Nine-banded armadillo (*Dasypus novemcinctus*)	3.4	Mean: [144] and [145]

Supplementary Table B continued..

Order Pilosa			
	Brown-throated three-toed sloth (*Bradypus variegatus*)	5.5	[146]
	Giant anteater (*Myrmecophaga tridactyla*)	4.6	[147]
	Hoffmann's two toed sloth (*Choloepus hoffmani*)	3.0	Mean: [146] and [148]
	Linnaeus's or southern two-toed sloth (*Choloepus didactylus*)	1.2	[149]
	Tamandua (*Tamandua* sp.)	4.7	[147]
Magnorder Boreoeutheria			
Super-order Laurasiatheria			
Order Eulipotyphla (formerly Soricomorpha)			
	European hedgehog (*Erinaceous europaeus*)	6.0	[133]
	Four-toed hedgehog (*Atelerix albiventris*)	5.1	[133]
	Least shrew (*Cryptotis parva*)	7.1	[150]
	Japanese shrew mole (*Atelerix albiventris*)	8.7	[133]
	Old World mole (*Atelerix frontalis*)	9.1	[133]
	South African hedgehog (*Atelerix frontalis*)	7.4	[133]
Order Chiroptera			
Sub-order Microchiroptera			
Family Phyllostomidae			
	Common vampire bat (*Desmodus rotundus*)	4.9	[151]
	Fruitbat (*Artibeus lituratus*)	6.9	[152]
Family Molossidae			
	Velvety free-tailed or Pallas's mastiff bat (*Molossus molossus*)	5.8	[153]
Family Vespertilionidae			
	Asiatic greater yellow house bat (*Scotophilus heathi*)	4.0	[154]
Sub-order Megachiroptera			
Family Pteropodidae			
	Egyptian fruitbat or Egyptian rousette (*Rousettus aegyptiacus*)	6.0	[155]
	Island flying fox (*Pteropus hypomelanus*)	8.6	[156]
	Malaysian flying fox (*Pteropus vampyrus*)	6.65	Mean: [155] and [156]
	Rodriquez Island flying fox (*Pteropus rodricensis*)	6.5	[156]
	Small flying fox or variable flying fox (*Pteropus hypomelanus*)	5.2	[155]
	Wahlberg's epauletted fruit bat (*Epomophorus wahlbergi*)	5.2	[157]
Order Cetacea			
	Amazon river porpoise (*Inia geoffrensis*)	6.7	[158]
	Atlantic bottlenose dolphin (*Tursiops truncatus*)	6.2	Mean: [158] and [159]
	Beluga whale (*Delphinapterus leucas*)	6.4	[160]
	Bowhead whale (*Balaena mysticetus*)	5.3	[161]
	Bryde's whale (*Balaenoptera edeni*)	8.4	[162]

Supplementary Table B continued..

	Commerson's dolphin (*Cephalorhynchus commersonii*)	5.5	[163]
	Common dolphin (*Delphinus delphius*)	5.8	[163]
	Dall porpoise (*Phocoenoides dalli*)	7.7	[158]
	False killer Whale (*Pseudorca crassidens*)	6.3	[163]
	Finless porpoise (*Neophocaena phocaenoides*)	7.85	Mean: [164] and [165]
	Gray whale (*Eschrichtius robustus*)	5.4	[163]
	Killer whale (*Orcinus orca*)	8.95	Mean: [158] and [160]
	Pacific white-striped porpoise (*Lagenorhynchus obliquidens*)	6.5	[158]
	Pilot whale (*Globicephala scammoni*)	8.1	[158]
	Spotted dolphin (*Stenella attenuata*)	7.7	Mean: [166] and [167]
Order Artiodactyla			
Family Antilocapridae			
	Pronghorn (*Antilocapra americana*)	13.2	[168]
Family Bovidae			
Subfamily Aepycerotinae			
	Impala (*Aepyceros melampus*)	7.55	[169]
Subfamily Alcelaphinae			
	Blesbok or Bontebok (*Damaliscus dorcas phillipsi*)	6.5	[170]
	Brindled gnu (*Connochoetes laurinus laurinus*)	9.0	[170]
	White-bearded gnu (*Connochaetes taurinus albojubatus*)	5.7	Mean: [170] and [171]
	White-tailed gnu or Black wildebeest (*Connochaetes gnou*)	9.3	[170]
Subfamily Antilopinae			
	Cuvier's gazelle (*Gazella cuvieri*)	4.5	[172]
	Dama gazelle (*Gazella dama*)	6.4	[172]
	Dorcas gazelles (*Gazella dorcas*)	7.0	[173]
	Erlanger's gazelle (*Gazella erlangeri*)	9.6	[174]
	Goitered gazelle (*Gazella subgutturosa*)	5.0	[175] and [176]
	Grant's gazelle (*Gazella granti*)	10.2	[177]
	Springbok (*Antidorcas marsupialis*)	8.4	[170]
Subfamily Bovinae			
	American bison (*Bison bison*)	8.4	Mean: [178] and [179]
	European bison (*Bison bonasus*)	6.8	[171]
	Bongo (*Tragelaphus eurycerus)*	6.2	[169]
	Bushbuck (*Tragelaphus scriptus*)	5.1	[169]
	Greater kudu (*Tragelaphus strepsiceros*)	9.2	[169]

Supplementary Table B continued..

	Lesser kudu (*Ammelaphus imberbis*)	10.0	[169]
	Common eland (*Taurotragus oryx*)	10.3	[169]
	Domestic cattle *(Bos primigenius*, formerly *Bos taurus)*	5.2	Mean: [180] and [181]
	Gayal – domesticated gaur (*Bos gaurus*)	2.7	[182]
	Nilgai (*Boselaphus tragocamelus*)	7.9	[171]
	Water buffalo (*Bubalus bubalis*)	3.2	[183]
Subfamily Caprinae			
	Barbary sheep (*Ammotragus lervia*)	10.3	[171]
	Bighorn sheep (*Ovis canadensis*)	8.7	Mean: [184] and [185]
	Mouflon (*Ovis ammon*)	8.9	[186]
	Domestic sheep (*Ovis aries*)	4.14	Mean: [187] and [188]
	Stone sheep (*Ovis dalli*)	11.7	Mean: [189] and [190]
	Domestic goat (*Capra aegagrus hircus*)	4.25	Mean: [191] and [192]
	Spanish ibex (*Capra pyrenaica*)	10.3	Mean: [193] and [194]
	Southern chamois (*Rupicapra pyrenaica*)	6.8	[195]
Subfamily Cephalophinae			
	Maxwell's duiker (*Philantomba maxwellii*)	7.1	[196]
Subfamily Hippotraginae			
	Addax (*Addax nasomaculatus*)	5.2	[169]
	Arabian oryx (*Oryx leucoryx*)	10.8	[197]
	Gemsbok or gemsbuck (*Oryx gazella*)	10.7	[169]
	Scimitar-horned Orvx (*Oryx dammah)*	14.0	[169]
	Roan antelope (*Hippotragus equinus*)	11.3	[169]
	Sable antelope (*Hippotragus niger*)	8.7	[169]
Subfamily Reduncinae			
	Mountain reedbuck (*Redunca fulvorufula*)	9.6	Mean: [170] and [198]
	Eastern waterbuck (*Kobus ellipsiprymnus ellipsiprymnus*)	10.7	[170]
	Defassa waterbuck (*Kobus ellipsiprymnus defossa*)	10.2	[170]
	Lechwe waterbuck (*Kobus leche*)	10.3	[170]
	Lady Gray's waterbuck (*Kobus megaceros*)	7.2	[170]
Family Camelidae			
	Camel (*Camelus dromedaries*)	4.1	Mean: [199] and [200]
	Llama (*Lama glama*)	5.5	Mean: [201] and [202]
	Guanaco (*Lama guanicoe*)	7.6	[203]
	Alpaca (*Vicugna pacos*)	6.4	Mean: [202] and [204]

Supplementary Table B continued..

Family Cervidae			
Subfamily Cervinae			
	Ambar (*Cervus unicolor*)	8.5	[171]
	Barking deer (*Muntiacus muntjak*)	5.2	[205]
	Chital deer (*Axis axis*)	7.4	Mean: [171] and [206]
	Fallow deer (*Dama dama*)	7.02	Mean: [171], [207] and [208]
	Eld's deer (*Panolia eldii*)	6.62	[209]
	Elk (*Cervus canadensis*)	8.7	[210]
	Red deer (*Cervus elaphus*)	9.71	Mean: [171], [208] and [211]
	Rusa deer (*Cervus timorensis*)	4.5	[212]
	Père David deer (*Elaphurus davidianus*)	11.2	[171]
Subfamily Capreolinae			
	Alaskan moose (*Alces alces*)	7.8	[213]
	Boreal caribou (*Rangifer tarandus caribou*)	8.3	[214]
	Pudú (*Pudu pudu*)	5.7	[215]
	Roe deer (*Capreolus capreolus*)	10.0	[216]
	White-tailed deer (*Odocoileus virginianus*)	10.1	Mean: [217] and [218]
Family Giraffidae			
	Giraffe (*Giraffa camelopardalis*)	9.0 (free ranging) (captive 6.3)	[219]
	Okapi (*Okapia johnstoni*)	8.0	[220]
Family Hippopotamidae			
	Hippopotamus (*Hippopotamus amphibius*)	7.5	Calculated from [221]
	Pygmy hippopotamus (*Choeropsis liberiensis*)	8.6	Calculated from [222]
Family Suidae			
	Buru babirusa (*Babyrousa babyrussa*)	6.0	Calculated from [222]
	European wild boar (*Sus scrofa*)	9.3	[223], [224] and [225]
	Feral pig (*Sus scrofa*)	7.8	[226]
	Domestic pig (*Sus scrofa domestica*)	3.7	[227]
	Red river hog (*Potamochoerus porcus*)	4.5	Calculated from [222]
	Warthog (*Phacochoerus africanus*)	4.5	Calculated from [222]
Family Tayassuidae			
	Collared peccary (*Tayassu tajacu*)	6.1	[228]
	Chacoan peccary (*Catagonus wagneri*)	6.1	Calculated from [222]

Supplementary Table B continued..

Order Carnivora			
Sub-order Feliformia			
Family Eupleridae			
	Fossa (*Cryptoprocta ferox)*	7.8	[229]
Family Felidae			
Subfamily Pantherinae			
	Bengal tiger *(Panthera tigris tigris)*	7.1	[230]
Subfamily Felinae			
	Bobcat (*Felis rufus* Scheber)	7.2	Mean: [231] and [232]
	European wildcat (*Felis silvestris*)	9.3	[233]
	Domestic cat (*Felis silvestris*)	8.1	[234]
	Sand cat (*Felis margarita*)	8.2	[235]
	Florida panther (*Felis concolor coryi*)	8.6	[236]
	Mountain lion (*Felis concolor*)	8.1	[237]
	Iriomote cat (*Felis iriomotensis*)	9.1	[238]
	Iberian lynx (*Lynx pardina*)	7.6	[239]
	Canada lynx (*Lynx canadensis*)	7.4	[240]
	Cheetah (*Acinonyx jubatus*)	6.5	[241]
	Jaguar (*Panthera onca*)	4.67	[242]
Family Herpestidae			
	Egyptian mongoose (*Herpestes ichneumon*)	9.7	[243]
	Slender-tailed meerkat (*Suricata suricatta*)	6.8	[244]
	Dwarf mongoose (*Helogale parvula*)	7.6	[245]
	Binturong (*Arctictis binturong*)	7.1	[244]
Family Hyaenidae			
	Aardwolf (*Proteles cristata*)	6.0	[245]
	Spotted hyena (*Crocuta crocuta*)	7.2	[245]
	Striped hyena (*Hyaena hyaena*)	6.1	[245]
Sub-order Caniformia (or Canoidea)			
Family Ailuridae			
	Red panda (*Ailurus fulgens*)	6.4	[246]
Family Canidae			
Subfamily Caninae			
	Coyote (*Canis latrans*)	8.2	Mean: [247] and [248]
	Grey wolf (*Canis lupo*)	5.6	[249]
	Domestic dog (*Canis lupo familiaris*, formerly *Canis familiaris*)	3.4	[250]
	Golden jackal (*Canis aureus syriacus*)	6.6	[251]
	Maned wolf (*Chrysocyon brachyurus*)	5.9	[252]
	Cape hunting dog (*Lycaon pictus*)	6.8	[253]
	Raccoon dog (*Nyctereutes procyonoides*)	3.3	[254]
	Crab-eating fox (*Cerdocyon thous*)	13.7	[255]

Supplementary Table B continued..

	Gray fox (*Urocyon cinereoargenteus*)	7.6	[256]
	Kit fox (*Vulpes macrotis mutica*)	7.2	[257]
	Swift fox (*Vulpes velox*)	5.6	[258]
	Silver fox (*Vulpes fulva*)	7.6	[254]
Family Mephitidae			
	Striped skunk (*Mephitis mephitis*)	13.3	[259]
Family Procyonidae			
	Common raccoon (*Procyon lotor*)	3.6	[244]
	Kinkajou (*Potos flavus*)	5.5	[244]
	Ringtail (*Bassariscus astutus*)	6.3	[244]
	South American coati (*Nasua nasua*)	5.6	[244]
	White-nosed coati (*Nasua narica*)	5.4	[244]
Family Mustelidae			
Subfamily Mustelinae			
	American badger (*Taxidea taxus*)	6.1	[260]
	American marten (*Martes canadensi*)	13.0	[261]
	European polecat (*Mustela putorius*)	9.3	[262]
	Ferret (*Mustela putorius furo*)	5.8	[263]
	Mink (*Mustela vison*)	6.9	[264]
Subfamily Lutrinae			
	Sea otter (*Enhydra lutris*)	6.9	[265]
	River otter (*Lontra canadensis*)	5.9	[266]
	Eurasian otter (*Lutra lutra lutra*)	5.6	[267]
	Giant otter (*Pteronura brasiliensis*)	5.6	[268]
Family Ursidae			
	American black bear (*Ursus americanus*)	4.0	[269]
	Brown bear (*Ursus arctos*)	6.65	Mean: [270] and [271]
	Polar bear (*Ursus maritimus*)	6.2	[272]
	Andean bear (*Tremarctos ornatu*)	3.6	[273]
	Malayan sun bear (*Helarctos malayanus*)	5.1	[274]
	Giant panda (*Ailuropoda melanoleuca*)	5.1	[275]
	Sloth bear (*Melursus ursinus*)	5.1	[274]
	Spectacled bear (*Tremarctos ornatus*)	5.7	[274]
	Sun bear	5.3	[245]
Family Odobenidae			
	Walrus (*Odobenus rosmarus*)	5.4	Calculated from [276]
Family Otariidae			
	Australian sea lion (*Neophoca cinerea*)	4.3	[277]
	California sea lion (*Zalophus californianus*)	7.5	[277]
	Northern fur seal (*Callorhinus ursinus*)	5.8	[278]
Family Phocidae			
	Harbor seal (*Phoca vitulina*)	10.5	[279]

Supplementary Table B continued..

	Harp seal (*Phoca groenlandica*)	9.8	[280]
	Hooded seal (*Cystophora cristata*)	7.1	[280]
	Northern elephant seal (*Mirounga angustirostris*)	5.8	[281]
Order Perissodactyla			
Sub-order Ceratomorpha			
Family Rhinocerotidae			
	Black rhinoceros (*Diceros bicornis*)	4.9	Mean: [282] and [283]
	Indian rhinoceros (*Rhinoceros unicornis*)	4.6	[221]
	Sumatran rhinoceros (*Dicerorhinus sumatrensis*)	4.2	[221]
	White rhinoceros (*Ceratotherium simum*)	5.6	[284]
Family Tapiridae			
	Baird's tapir (*Tapirus bairdii*)	4.8	[285]
	Brazilian tapir (*Tapirus terrestris*)	4.3	[286]
	Malayan tapir (*Tapirus indicus*)	5.6	[287]
	Mountain tapir (*Tapirus pinchaque*)	6.4	[287]
Sub-order Hippomorpha			
Family Equidae			
	African wild ass (*Equus africanus*)	6.0	[288]
	Grevy's zebra (*Equus grevyi*)	6.0	[289]
	Horse (*Equus ferus*)	6.4	Mean: [290] and [291]
	Feral horse (*Equus caballus*)	7.3	[292]
	Mountain zebra (*Equus zebra*)	6.9	[293]
	Onager (*Equus hemionus*)	9.0	[289]
	Plains zebra (*Equus quagga*)	8.8	[289]
	Przewalski horse (*Equus przewalsk iprzewalski*)	7.2	[293]
Super-order Euarchontoglires			
Grandorder or Clade Glires			
Order Lagomorpha			
	Cottontail rabbit (*Sylvilagus floridanus*)	12.9	[294]
	Riparian brush rabbit (*Sylvilagus bachmani*)	6.3	[295]
	European or brown hare (*Lepus europaeus*)	12.9	[296]
	Black-tailed jackrabbit (*Lepus californicus*)	8.7	[297]
	Domestic rabbit (*Oryctolagus cuniculus*)	6.85	Mean: [250] and [298]
Order Rodentia			
Sub-order Castorimorpha			
Family Heteromyidae			
	Kangaroo rat (*Dipodomys merriami*)	14.3	[299]
Sub-order Sciuromorpha			
Family Sciuridae			
	Gray squirrel (*Sciurus carolinensis*)	7.7	[300]
	Thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*)	9.0	[301]

Supplementary Table B continued..

	White-tailed prairie dog (*Cynomys leucurus*)	8.0	[261]
Sub-order Hystricomorpha			
Family Caviidae			
	Guinea pig (*Cavia porcellus*)	6.7	[302]
Family Chinchillidae			
	Long-tailed chinchilla (*Chinchilla lanigera*)	7.0	[302]
Family Erethizontidae			
	Brazilian porcupine (*Coendou prehensilis*)	5.5	[303]
	Black-tailed hairy dwarf porcupine (*Coendou melanurus*)	3.95	[303]
Family Myocastoridae			
	Nutria (*Myocastor coypus*)	8.9	[304]
Family Ctenomyidae			
	Tuco-tuco (*Ctenomys talarum*)	5.2	[305]
Family Thryonomyidae			
	Greater cane rat (*Thryonomys swinderianus*)	5.15	[306]
Sub-order Myomorpha			
Family Cricetidae			
	Bank vole (*Myodes glareolus*)	3.95	[307]
	Deer mice (*Peromyscus maniculatus*)	5.6	[308]
	Golden or Syrian Hamster (*Mesocricetus auratus*)	5.8	Mean: [250], [302] and [309]
	Grey red-backed vole (*Myodes rufocanus*)	5.3	[310]
	Dusky-footed wood rat (*Neotoma fuscipes*)	6.4	[311]
	Northern red-backed vole (*Myodes rutilus*)	4.4	[310]
	Norwegian lemming (*Lemmus lemmus*)	7.3	[312]
	Meadow vole (*Microtus pennylvanicus*)	5.7	[313]
	Muskrat (*Ondatra zibethicus*)	13.4	[314]
	Pine vole (*Microtus pinetorum*)	5.6	[315]
Family Muridae			
	Central rock-rat (*Zyzomys pedunculatus*)	3.8	[316]
	Fat-tailed jird (*Pachyuromys duprasi*)	12.2	[317]
	Gerbil (*Meriones unguiculatus*)	4.3	[318]
	Indian desert jird (*Meriones hurrianae*)	5.9	[319]
	Indian gerbil (*Tatera indica*)	5.9	[320]
	Libyan jird (*Meriones libycus*)	6.4	Mean: [320] and [321]
	Mongolian jird or Mongolian gerbil domesticated (*Meriones unguiculatus*)	5.0	[302]
	Mouse (*Mus musculus*)	5.05	Mean: [250] and [322]
	Norway rat (*Rattus norvegicus*)	5.1	[302]
	Persian jird (*Meriones persicus*)	6.7	[320]
	Rat (*Rattus norvegicus*)	6.95	Mean: [250] and [323]
	Sand rat (*Psammomys obesus*)	4.3	[324]

Supplementary Table B continued..

	Short-tailed bandicoot rat (*Nesokia indica*)	6.7	[320]
	Spiny mice (*Acomys cahirinus*)	8.8	[325]
Family Spalacidae			
	Blind subterranean mole rat (*Spalax judaei*)	8.61	[326]
Grandorder or Clade Euarchonta			
Order Primates			
Sub-order Strepsirrhines			
	Black lemur (*Eulemur macaco*)	4.9	[327]
	Black-and-white ruffed lemur (*Varecia variegata*)	6.7	[328]
	Bushbaby (*Galago crassicaudatus*)	5.4	[329]
	Red ruffed lemur (*Varecia rubra*)	5.5	[330]
	Eastern lesser bamboo lemur (*Hapalemur griseus*)	6.4	[327]
	Ring-tailed lemur (*Lemur catta*)	7.5	[331]
	Slender loris (*Loris tardigradus*)	7.5	[327]
	Verreaux's sifaka (*Propithecus verreauxi*)	6.6	[327]
	White-fronted brown lemur (*Eulemur fulvus albifrons*)	3.0	[332]
Sub-order Haplorhini			
Parv-order Platyrrhini (New World monkeys)			
Family Callitrichidae			
	Common marmoset (*Callithrix jacchus*)	10.6	[333]
	Cotton-top tamarins (*Saguinus oedipus*)	14.7	[334]
	Goeldi's monkey (*Callimico goeldii*)	8.9	[335]
	White-footed tamarin (*Saguinus leucopus*)	9.4	[336]
Family Aotidae			
	Three-striped night monkey (*Aotus trivirgatus*)	9.1	[333]
	Brown woolly monkey (*Lagothrix lagotricha*)	5.1	[333]
Family Atelidae			
	Owl monkey (*Aotus nancymaae*)	6.5	[337]
	Red howler monkey (*Alouatta seniculus*)	5.7	[338]
	Woolly monkey (*Lagothrix lagotricha*)	6.7	[339]
Family Cebidae			
	Black-capped or Bolivian squirrel monkey (*Saimiri boliviensis*)	7.8	[340]
	Central American squirrel or Colombian monkey (*Saimiri oerstedii*)	6.4	[340]
	Common squirrel monkey (*Saimiri sciureus*)	4.9	[333]
	Squirrel monkey (*Saimiri sciureus*)	7.6	Mean: [329] and [341]
	Tufted capuchin (*Cebus apella*)	7.2	[333]
Parv-order Catarrhini			
Family Cercopithecidae (Old World monkeys)			
	Chacma or Cape baboon (*Papio ursinus*)	5.4	Mean: [342] and [343]
	Celebes black macaques (*Macaca nigra*)	4.0	[344]
	Crab-eating or Cynomolgus macaque (*Macaca fascicularis*)	5.87	Mean: [329], [250] and [345]

Supplementary Table B continued..

	De Brazza's Monkey (*Cercopithecus neglectus*)	4.3	[333]
	Grivet or African Green monkey (*Chlorocebus aethiops*)	5.8	[346]
	Hamadryas baboon (*Papio hamadryas*)	4.3	[333]
	Indian bonnet monkey (*Macaca radiata radiata*)	3.3	[347]
	Lion-tailed macaque (*Macaca silenus*)	5.8	[333]
	Northern plains gray langur (*Semnopithecus entellus*)	5.9	[346]
	Rhesus monkey (*Macaca mulatta*)	4.05	Mean: [329] and [348]
	Sooty mangabey (*Cercocebus atys*)	4.8	[346]
	Tonkean macaques (*Macaca tonkeana*)	3.4	[349]
Family *Hominidae*			
	Bonobo (*Pan paniscus*)	4.1	[350]
	Chimpanzee (*Pan troglodytes*)	4.7	Mean: [350], [351] and [352]
	Gorilla (*Gorilla gorilla*)	4.4	[353]
	Human (*Homo sapiens*)	7.3	e.g. [354]
	Orangutan (*Pongo pygmaeus*)	4.3	[355]

Supplementary Table C. Circulating concentrations of glucose in species of reptiles.

Classification	Species	Glucose mM (mmoles l^{-1})	Reference
Order Testudines			
Family Cheloniidae			
	Loggerhead sea turtle (*Caretta caretta*)	2.15	Mean: [356] and [357]
	Geoffroy's toadhead turtle (*Phrynops geoffroanus*)	5.5	[356]
	Hilaire's toadhead turtle (*Phynops hilarii*)	5.5	[358]
	Kemp's ridley sea turtle (*Lepidochelys kempii*)	5.1	[359]
	Green sea turtle (*Chelonia mydas*)	5.8	Mean: [359], [360] and [361]
	New Guinea snapping turtle (*Elseya novaeguineae*)	6.9	[362]
Family Chelydridae			
	Alligator snapping turtle (*Macrochelys temminckii*)	2.7	[363]
	Common snapping turtle (*Chelydra serpentina*)	1.8	[356]
Family Dermochelyidae			
	Leatherback sea turtle (*Dermochelys coriacea*)	4.65	Mean: [364] and [365]
Family Dermatemydidae			
	Central American river turtle (*Dermatemys mawii*)	3.9	[366]
Family Emydidae			
	Bog turtle (*Clemmys muhlenbergii*)	3.8	[367]
	Painted turtle (*Chrysemys picta*)	4.2	[356]
	D'Orbigny's slider (*Pseudemys dorbigni*)	4.3	[356]

Supplementary Table C continued..

	Big Bend slider (*Pseudemys scripta*)	3.9	[356]
	Common box turtle (*Terrapene carolina*)	2.0	[356]
	European pond turtle (*Emys orbicularis*)	2.8	[356]
Family Geoemydidae			
	Brown roofed turtle (*Pangshura smithii*) formerly *Kachuga smithii*	4.3	[356]
	Indian black turtle or Indian pond terrapin (*Melanochelys trijuga*)	5.1	[356]
	Freshwater turtle (*Mauremys leprosa*)	4.8	[368]
	Mediterranean pond turtle (*Mauremys leprosa*)	4.1	[356]
Family Testudinidae			
	Angonoka tortoise (*Astrochelys yniphora*)	2.6	[368]
	Desert tortoise (*Gopherus agassizzi*)	4.15	Mean: [369] and [370]
	Hermann's tortoises (*Testudo hermanni*)	2.4	[371]
	Marginated tortoise (*Testudo marginata*)	3.1	[372]
	Pancake tortoise (*Malacochersus tornieri*)	5.3	[373]
	Radiated tortoise (*Geochelone radiata*)	3.7	Mean: [368] and [374]
	Russian tortoise (*Agrionemys horsfieldi*)	11.4	[375]
Family Trionychidae			
	Indian flapshell turtle (*Lissemys punctata*)	4.2	Mean: [356] and [376]
Order Squamata (Sauria)			
Sub-order Scleroglossa			
Infra-order Gekkota			
Family Gekkonidae			
	Tokay gecko (*Gekko gecko*)	5.2	[356]
	House gecko (Genus *Hemidactylus*)	3.0	[356]
	Persian spider gecko (*Agama persica*)	6.3^{Δ}	[377]
	Terrestrial gecko (Genus *Coleonyx*)	5.2	[356]
Infra-order Scincomorpha			
Family Lacertidae			
	El Hierro giant lizard (*Gallotia simonyi*)	6.7	[378]
	La Gemera giant lizard (*Gallotia bravoana*)	9.3	[378]
	Tenerife giant lizard (*Gallotia intermedia*)	10.7	[378]
	Large psammodromus (*Psammodromus alginus*)	14.8	[379]
	Acandodactylus scutellatus	12.5^{Δ}	[380]
	Eremias brevirostiris	12.1^{Δ}	[380]
Family Scincidae			
	American five-lined skink (*Eumeces fasciatus*)	5.9	[356]
	Great plains skink (*Eumeces obsoletus*)	6.2	[356]
	Keeled Indian mabuya (*Eutropis carinata*)	11.1	[376]
	Solomon Islands skink or Prehensile-tailed skink (*Corucia zebrata*)	5.5	[381]

Supplementary Table C continued..

Family Teiidae			
	Six-lined Racerunner (*Cnemidophorus sexlineatus*)	5.2	[356]
	Gold tegu (*Tupinambis teguixin*)	5.8	[356]
Infra-order Anguimorpha			
Family Helodermatidae			
	Beaded lizard (*Heloderma horridum*)	3.55	[356]
	Gila monster (*Heloderma suspectum*)	4.4	Mean: [356] and [382]
Family Varanidae			
	Monitor lizard (Genus *Varanus*)	5.9	[356]
	Dumeril's monitor (*Varanus dumerilii*)	4.55	[383]
	Komodo dragon (*Varanus komodoensis*)	10.1	[384]
	Salvadori's monitor (*Varanus salvadorii*)	8.3	[385]
Sub-order Iguania			
Family Agamidae			
	Chinese water dragon (*Physignathus concincinus*)	8.7	[386]
	Inland bearded dragon (*Pogona vitticeps*)	11.7	[387]
	Hardwicke's or Indian spiny-tailed lizard (*Uromastyx hardwickii*)	7.5	[388]
	Oriental garden lizard (*Calotes versicolor*)	9.6	[376]
	Spiny-tailed lizard (*Uromastyx microlepis*)	8.4	[389]
	Uromastix microlepis	6.9^{Δ}	[390]
Family Chameleonidae			
	Common chameleon (*Chamaeleo chamaeleon*)	14.85	Mean [356] and [394]
	Warty chameleon (*Furcifer verrucosus*)	10.4	[391]
Family Iguanidae			
	Brown anole (*Anolis sagrei*)	4.8	[392]
	Carolina anole (*Anolis carolinensis*)	10.15	Mean: [356] and [393]
	Desert iguana (*Dipsosaurus dorsalis*)	19.7	[395]
	North eastern spinytail iguana (*Ctenosaura acanthura*)	10.7	[356]
	Green iguana or common iguana (*Iguana iguana*)	9.45	[356]
	Texas horned lizard (*Phrynosoma cornutum*)	10.6	[356]
	Northern Bahamian rock iguana (*Cyclura cychlura*)	6.5	[396]
	Eastern fence lizard (*Sceloporus undulatus*)	7.8	[356]
	Spiny-tailed lizard (Genus *Uromastyx*)	6.7	[356]
	Hardwicke's or Indian spiny-tailed lizard (*Saara hardwickii*)	7.7	[397]
	Basilisk lizard (*Basiliscus plumifrons*)	10.7	[398]
Sub-order Serpentes			
Family Boidae			
	Boa constrictor (*Boa constrictor*)	2.5	[356]
	Rosy boa (*Lichanura trivirgata*)	4.1	[356]
	Rainbow boa (*Epicrates cenchria*)	5.2	[356]

Supplementary Table C continued..

	Indian sand boa (*Eryx johnii*)	1.4	[356]
	Green or common anaconda (*Eunectes murinus*)	3.0	[399]
Family Colubridae			
	Brown tree snake (*Boiga irregularis*)	2.6	[400]
	Eastern racer (*Coluber constrictor*)	4.2	[356]
	Eastern hog-nosed snake (*Heterodon platyrhinos*)	2. 9	[356]
	Eastern kingsnake (*Lampropeltis getulus*)	3.3	[356]
	Grass snake (*Natrix natrix*)	3.2	[356]
	Green water snake (*Natrix cyclopion*)	3.6	[356]
	Green whip snake (*Hierophis* or *Coluber viridiflavus*)	3.6	[356]
	Hissing sand snake (*Psammophis sibilans*)	7.1	[401]
	Indigo snake (*Drymarchon corais*)	2.5	[402]
	Long-nosed snake (*Rhinocheilus lecontei*)	4.9	[356]
	Wagler's snake (*Xenodon merremi*)	3.2	[356]
	Diamond-backed water snake (*Nerodia rhombifer*)	1.7	[356]
	Northern water snake (*Nerodia sipedon*)	2.7	[356]
	Short snouted grass snake (*Psammophis sibilans*)	6.5	[402]
	Diamond back water snake (*Nerodia rhombifera*)	1.8	[403]
	Giant garter snake (*Thamnophis gigas*)	4.5	[404]
	Valley garter snake (*Thamnophis sirtalis fitchi*)	4.9	[404]
Family Elapidae			
	Central American coral snake (*Micrurus nigrocinctus*)	5.9	[356]
	Indian cobra (*Naja naja*)	1.6	[356]
Family Viperidae			
	Asp (*Vipera aspis*)	2.2	[356]
	Genus *Vipera*	1.9	[356]
	Common lancehead (*Bothrops atrox*)	3.3	[356]
	Eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*)	3.9	[405]
	Prairie rattlesnake (*Crotalus viridis*)	2.7	[356]
	Red diamond rattlesnake (*Crotalus ruber*)	3.9	[356]
	South American rattlesnake (*Crotalis durissus*)	1.3	[406]
	Timber rattlesnake (*Crotalus horridus*)	3.3	[356]
	Water moccasin (*Agkistrodon piscivorus*)	2.9	[356]
	Western diamond back rattlesnake (*Crotalus atrox*)	3.3	[356]
	Nose-horned viper (*Vipera ammodytes*)	10.2	[407]
	African puff adder (*Bitis arietans*)	1.5	[408]
	Patagonian lancehead (*Bothrops ammodytoides*)	1.8	[409]
Family Typhlopidae			
	Blind snake of genus *Typhlops*	4.7	[356]
Family Pythonidae			
	Burmese python (*Python molurus*)	3.3	[410]
	Southern carpet python (*Morelia spilotaimbricata*)	2.84	[411]

Supplementary Table C continued..

Order Crocodilia			
	American alligator (*Alligator mississippiensis*)	4.1; 7.4 5.7	Mean: [356] and [412]
	American crocodile (*Crocodylus acutus*)	5.6	[356]
	Broad-snouted caiman (*Caiman latirostris*)	4.3	[413]
	Morelet's crocodile (*Crocodylus moreletii*)	7.0	[414]
	Mugger crocodile (*Crocodylus palustris*)	3.6	[415]
	Nile crocodile (*Crocodylus niloticus*)	3.8	[416]
	Orinoco crocodile (*Crocodylus intermedius*)	3.85	[417]

[Δ]Glucose determined in blood.

Supplementary Table D. Circulating concentrations of glucose in species of amphibians and other lower vertebrates.

	Species	Glucose mmoles L^{-1} (mM)	References
Class Amphibia			
	Ozark hellbender (*Cryobranchus alleganiensis*)	1.2	[418]
	Pyrenean newt (*Calotriton asper*)	6.9	[419]
	African clawed frog (*Xenopus laevis*)	2.4	[420]
	American bullfrog (*Rana catesbeiana*)	2.2	[421]
	Northern leopard frog (*Rana pipiens*)	0.9	[422]
	Common or European common frog (*Rana temporaria*)	5.4	[89]
	Wood frog(*Rana sylvatica*)	6.0	[423]
	Indus valley bullfrog or Indian bullfrog (*Hoplobatrachus tigerinus* or *Rana tigerinus*)	0.9	[424]
	Great plains toad (*Bufo cognatus*)	1.5	[425]
	Rococo toad (*Bufo paracnemis*)	1.5	[421]
	Western toad (*Bufo boreas*)	2.1	[426]
Class Sarcopterygii			
Sub-class Actinistia			
	Coelacanth (*Latimeria chalumnae* Smith)	6.6	[427]
Sub-class Dipnoi			
	African lungfish (*Protopterus dolloi*)	1.3	[428]
	Lungfish (*Protopterus aethiopus*)	3.0	[429]
	Lungfish (*Protopterus annectens*)	2.1	[430]
Class Actinopterygii			
Sub-class Chondrostei			
Order Acipenseriformes			
	American paddlefish (*Polyodon spathula*)	4.2	[431]
	Lake sturgeon (*Acipenser fulvescens*)	3.4	[432]

Supplementary Table D continued..

	Shortnose sturgeon (*Acipenser brevirostrum*)	4.3	Mean: [434] and [435]
	Pallid sturgeon (*Scaphirhynchus albus*)	3.3	[436]
	Shovelnose sturgeon (*Scaphirhynchus platorynchus*)	5.9	[433]
	Sterlet (*Acipenser ruthenus*)	6.5	[437]
	White sturgeon (*Acipenser transmontanus*)	1.6	[438]
Sub-class Neopterygii			
Infra-class Holostei			
	Florida gar (*Lepisosteus platyrhincus*)	8.9	[439]
Infra-class Teleostei			
Super-order Elopomorpha			
Order Elopiformes			
	Atlantic tarpon (*Megalops atlanticus*)	3.6	[440]
Order Albuliformes			
	Bonefish (*Albula vulpes*)	4.1	[441]
Order Anguilliformes			
	American eel (*Anguilla rostrata*)	5.3	Mean: [442] and [443]
	European eel (*Anguilla anguilla*)	1.9 (Blood)	[444]
	Japanese eel (*Anguilla japonica*)	5.5	[445]
	Purple mouth moray eel (*Gymnothorax vicinus*)	1.2	[446]
Super-order Clupeomorpha			
Order Clupeiformes			
	Atlantic herring (*Clupea harengus*)	7.9	[447]
	Atlantic menhaden (*Brevoortia tyrannus*)	2.5	[448]
Super-order Ostariophysi			
Order Gonorynchiformes			
	Milkfish (*Chanos chanos*)	4.5	[449]
Order Cypriniformes			
	Bighead carp (*Aristichtuys nobilis*)	4.2	[449]
	Capoeta umbla	4.1	[450]
	Chub (*Squalius cephalus* or *Leuciscus cephalus*)	1.8	[451]
	Common carp (*Cyprinus carpio*)	3.05	Mean: [449] and [452]
	Dojo loach (*Misgurnus anguillicaudatus*)	4.7	[453]
	European minnow (*Phoxinus phoxinus*)	4.0	[454]
	Fat head minnow (*Pimephales promelas*)	3.0	[455]
	Goldfish (*Carassius auratus*)	2.8	[456]
	Grass carp (*Ctenopharyngodon iddela*)	4.8	Mean: [449], [457] and [458]

Supplementary Table D continued..

	Rio Grande silvery minnow (*Hybognathus amarus*)	2.1	[459]
	Spottail shiner (*Notropis hudsonius*) juvenile	1.2	[460]
	Tench (*Tinca tinca*)	6.0	[461]
	White sucker (*Catostomus commersonii*)	7.0	[462]
	Zebra fish (*Danio rerio*)	4.1	[463]
Order Characiformes			
	Matrinxa (*Bryconcephalus*), a species of South American trout	7.7	[464]
	Pacu (*Piaractus mesopotamicus*)	4.0	[465]
	Prochilodus lineatus	2.0	[466]
	Trahira (*Hoplias malabaricus*)	3.6	[467]
Order Siluriformes			
	African catfish (*Clarias gariepinus*)	3.0	[468]
	African sharptooth catfish (*Clarias lazera*)	6.9	[469]
	Black bullhead catfish (*Ameiurus melas*)	3.4	[442]
	Channel catfish (*Ictalurus punctatus*)	5.8	[470]
	Clarias gariepinus	4.7	[471]
	Jundiá (*Rhamdia quelen*)	3.1	[472]
	Mandi (*Pimelodus maculatus*)	3.6	[473]
Super-order Protacanthopterygii			
Order Salmoniformes			
	Chinook salmon (*Oncorhynchus tshawytscha*)	5.6	[474]
	Coho salmon (*Oncorhynchus kisutch*)	5.6	[475]
	Rainbow trout (*Oncorhynchus mykiss*)	6.3	Mean: [442], [476], [477] and [478]
	Brown trout (*Salmo trutta*)	4.95	Mean [479] and [480]
	Atlantic salmon (*Salmo salar*)	6.4	[481]
	Mountain whitefish (*Prosopium williamsoni*)	1.6	[482]
Order Esociformes			
	Northern pike (*Esox lucius*)	8.1	[462]
Super-order Paracanthopterygii			
Order Batrachoididae			
	Toad fish (*Halobatrachus didactylus*)	1.9 (Blood)	[483]
Order Gadiformes			
	Atlantic cod (*Gadus morhua*)	7.8	[484]
	Southern bastard codling or bearded red cod (*Pseudophycis barbata*)	3.3	[485]

Supplementary Table D continued..

Super-order Acanthopterygii			
Order Pleuronectiformes			
	English sole (*Pleuronectes vetulus*)	2.4	[486]
	European flounder (*Platichtys flesus*)	5.0	[487]
	Pacific halibut (*Hippoglossus stenolepis*)	2.5	[488]
	Plaice (*Pleuronectes platessa*)	5.0	[489]
	Turbot (*Scophthalmus maximus*)	2.5	[490]
Order Perciformes			
Sub-order Anabantoidei			
Family Anabantidae			
	Indian perch (*Anabas testudineus*)	5.6	[491]
Family Osphronemidae			
	Three spot gourami (*Trichopodus trichopterus*)	1.0	[492]
Sub-order Channoidei			
Family Channidae			
	African snakehead (*Parachanna obscura*)	3.7	[493]
Sub-order Gobioidei			
Family Gobiidae			
	Black goby (*Gobius niger*)	3.1	[494]
	Longjaw mudsucker (*Gillichthys mirabilis*)	6.0	[495]
Sub-order Labroidei			
Family Cichlidae			
	Tilapia (*Oreochromis niloticus*)	5.1	[496]
	Mozambique tilapia (*Oreochromis mossambicus*)	2.8	[497]
Family Pomacentridae			
	Cinnamon clownfish (*Amphiprion melanopus*)	2.4	[498]
Sub-order Mugiloidei			
Family Mugilidae			
	Striped mullet (*Mugil cephalus*)	2.5	[499]
	Grey mullet (*Mugil cephalus*)	4.3	[500]
Sub-order Notothenioidei			
Family Nototheniidae			
	Bald notothen (*Pagothenia borchgrevinki*)	4.5	[501]
	Emerald rockcod (*Trematomus bernacchii*)	1.5	[501]
Sub-order Scombroidei			
Family Scombridae			
	Atlantic mackerel (*Scomber scombrus*)	3.4 (Blood)	[502]
	Atlantic blue fin tuna (*Thunnus thynnus*)	4.6	[503]
	Southern bluefin tuna (*Thunnus maccoyii*)	3.3	[504]
	Skipjack tuna (*Katsuwonus pelamis*)	4.65	Mean: [505] and [506]

Supplementary Table D continued..

Family Sphyraenidae			
	Great barracuda (*Sphyraena barracuda*)	2.8	[507]
Sub-order Percoidei			
Family Carangidae			
	Mediterranean horse mackerel (*Trachurus mediterranius*)	4.9	[508]
Family Kyphosidae			
	Blue maomao (*Scorpis violaceus*)	4.5	[509]
	Parore (*Girella tricuspidata*)	2.25	Mean: [509] and [510]
	Silver drummer (*Kyphosus sydneyanus*)	2.4	[509]
Family Latidae			
	Barramundi or Asian seabass (*Lates calcarifer*)	3.6	[511]
Family Moronidae			
	European sea bass (*Dicentrarchus labrax*)	4.85	Mean [512] and [513]
	Sunshine or striped hybrid bass (hybrid of *Morone chrysops* and *Morone saxatilis*)	4.2	[514]
Family Percidae			
	Eurasian perch (*Perca fluviatilis*)	1.5	[515]
Family Sciaenidae			
	Shi drum (*Umbrina cirrosa*)	7.8	[516]
	Red drum (*Sciaenops ocellatus*)	2.3	[517]
Family Scorpaenidae			
	Lingcod (*Ophiodon elongatus*)	2.4	[518]
	Black scorpionfish (*Scorpaena porcus*)	5.0	[508]
	Black rockfish (*Sebastes melanops*)	2.5	[519]
	Sea raven (*Hemitripterus americanus*)	5.0	[520]
Family Serranidae			
	Coral trout (*Plectropomus maculatus*)	1.6	[521]
	Kelp bass (*Paralabrax clathratus*)	1.9	[522]
	Leopard coral trout (*Plectropomus leopardus*)	1.9	[521]
Family Sillaginidae			
	Sand whiting (*Sillago ciliata*)	3.4	[523]
Family Sparidae			
	Australasian snapper or Silver seabream (*Pagrus auratus*)	1.95	Mean: [524] and [525]
	Red porgy (*Pagrus pagrus*)	4.0	[526]
	Sea carp (*Diplodus annularis*)	2.5	[508]
Order Tetraodontiformes			
	Tiger pufferfish (*Takifugu rubripes*)	1.9	[527]

Supplementary Table D continued..

Class Chondrichthyes			
Sub-class Holocephali			
	Elephant or Australian ghost shark (*Callorhincus millii*)	4.0	[528]
Sub-class Elasmobranchii			
Super-order Selachii			
	Atlantic blue nose shark (*Rhizoprionodon terraenovae*)	7.9	[529]
	Blue shark (*Prionace glauca*)	5.9	[529]
	Blacktip shark (*Carcharhinus limbatus*)	5.7	[529]
	Dusky shark (*Carcharhinus obscurus*)	6.0	[529]
	Oceanic white tip shark (*Carcharhinus longimanus*)	4.6	[529]
	Sandbar shark (*Carcharhinus plumbeus*)	4.3	[529]
	Silky shark (*Carcharhinus falciformis*)	7.0	[529]
	Bonnethead shark (*Sphyrna tiburo*)	10.2	[530]
	Caribbean reef shark (*Carcharhinus perezi*)	4.0	[531]
	Dogfish shark (*Squalus acanthias*)	4.0	Mean: [528], [532] and [533]
	Spotted dogfish (*Scyliorhinus canicula*)	1.95	Mean [534] and [535]
	Pelagic thresher shark (*Alopias pelagicus*)	10.6	[529]
	Porbeagle shark (*Lamna nasus*)	6.9	[529]
	Shortfin mako shark (*Isurus oxyrinchus*)	6.7	[529]
	Tiger shark (*Galeocerdo cuvier*)	6.4	[529]
Super-order Batoidea			
	Cownose ray (*Rhinoptera bonasus*)	2.5	[536]
	Cururu stingray (*Potamotrygon cf.histrix*)	1.6	[537]
	Southern stingray (*Dasyatis americana*)	1.7	[538]
	Littleskate (*Leucoraja erinacea*)	1.9	[539]
Super-class Cyclostomata			
Order Petromyzontiformes			
	Caspian lamprey (*Caspiomyzon wagneri*)	5.2	[540]
	European river lamprey (*Lampetra fluviatilis L.*)	2.85 (Range by season 2.0–7.3)	Mean: [541] and [542]
	Pacific lamprey (*Entosphenus tridentatus*)	2.4	[541]
Order Myxiniformes			
	Atlantic hagfish (*Myxine glutinosa*)	1.9	[544]
	Pacific hagfish (*Eptatretus stouti*)	0.75	Mean: [543] and [545]

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