

Endocranial4.R

SIU850486795

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```
# Endocranial4.R
# Multiple regression for endocranial volume in mammals

# Load necessary libraries
library(ggplot2)
library(car)

## Loading required package: carData
library(QuantPsyc)

## Loading required package: boot
##
## Attaching package: 'boot'
## The following object is masked from 'package:car':
##
##      logit
## Loading required package: MASS
##
## Attaching package: 'QuantPsyc'
## The following object is masked from 'package:base':
##
##      norm

# Read in data set
ECVdat <- read.table(header=T,colClasses=c(rep("numeric",4),"factor"),text="
Length  Width  Height  Volume  Common_name
15.04   11.29   6.61    0.38    Pygmy_glider
52.40   30.94   25.68   12.36   Rufous_kangaroo_rat
75.87   52.79   39.45   56.70   Howler_monkey
41.73   25.70   16.79   5.68    Scaley-tailed_squirrel
39.71   26.87   17.13   5.92    Lord_derby's_flying_squirrel
18.90   12.62   7.61    0.51    Yellow-footed_antechinus
15.10   11.69   7.06    0.46    Brown_antechinus
123.70  73.89   63.93   150.53  Pronghorn
46.75   28.70   18.45   6.51    Mountain_beaver
154.32  103.77  71.95   284.03  Antarctic_fur_seal
133.39  59.75   72.60   128.49  Babiroussa
49.43   29.61   24.27   9.49    Burrowing_bettong
61.51   32.76   27.05   16.43   Pale_throated_sloth
36.65   23.94   19.64   6.22    Common_marmoset
```

37.96	22.94	16.72	4.71	Plantain_squirrel
30.10	18.69	12.75	2.20	Bare_tailed_wooly_opossum
227.53	96.85	100.03	547.78	Dromedary_camel
87.04	52.86	45.46	66.40	Golden_jackal
98.73	59.43	53.36	91.65	Coyote
121.53	73.22	61.13	135.40	Wolf
120.81	68.38	62.67	151.03	Wild_goat
102.14	59.34	50.41	94.82	Roe_deer
51.14	21.72	18.46	6.31	Hutia
83.34	40.79	33.60	37.88	American_beaver
42.17	23.14	16.20	3.93	Guinea_pig
73.58	52.90	42.11	67.96	Capuchin
98.54	59.24	49.03	82.44	Common_duiker
74.43	57.25	44.83	72.19	Guenon
70.37	54.11	44.03	65.96	Mona_monkey
39.62	23.90	17.39	4.39	Chinchilla
26.37	22.97	13.25	2.30	Pink_fairy_armadillo
93.63	49.10	43.75	35.10	Two_toed_tree_sloth
93.24	41.11	36.58	36.65	African_civet_cat
30.63	17.31	13.42	1.67	European_hamster
126.62	117.09	81.10	376.40	Hooded_seal
11.69	9.82	5.47	0.22	Olivers_shrew
159.07	82.94	80.42	164.22	Spotted_hyaena
28.23	17.47	13.22	2.37	Tuco-tuco
97.54	50.66	34.43	32.76	Paca
41.47	21.95	16.57	3.87	Prarie_dog
134.68	77.44	76.70	232.99	Fallow_deer
67.83	33.66	28.93	19.25	Golden_acouti
50.01	24.99	20.18	5.01	Southern_long_nosed_armadillo
62.29	30.57	25.52	11.45	Armadillo
43.00	23.88	16.47	4.28	Chuditch
53.27	27.81	21.63	8.45	Tiger_quoll
37.73	23.57	16.46	4.97	Quoll
70.40	44.74	38.94	40.26	Aye-aye
80.18	34.10	33.94	22.45	Tree_hyrax
18.20	12.87	10.06	0.87	Vampire_bat
51.10	25.83	20.13	6.02	American_opossum
22.16	16.88	12.42	1.53	Ord's_kangaroo_rat
159.31	116.10	111.67	418.77	Dugong
36.02	20.18	14.76	3.47	Equatorial_fruit_bat
109.38	79.78	48.74	127.26	Sea_otter
282.83	95.88	99.82	503.33	Horse
59.41	35.67	28.44	20.54	New_world_porcupine
36.22	23.15	15.16	3.27	Hedgehog
35.65	23.67	17.13	4.99	Galago
128.38	72.40	57.86	133.05	Puma
173.29	100.56	80.01	225.29	Lion
100.81	59.32	48.56	83.41	Lynx
76.86	47.30	36.21	41.07	Wild_cat
35.01	23.69	17.80	4.55	Allens_bushbaby
26.63	18.83	14.09	3.01	Demidoffs_bushbaby
42.06	25.63	16.80	5.61	Philippine_flying_lemur
95.40	56.17	50.88	76.72	Dorcas_gazelle

160.80	101.21	93.39	482.16	Western_gorilla
23.92	16.09	10.91	1.61	Huets_dormouse
104.47	67.64	44.41	80.51	Wolverine
38.37	23.24	16.73	4.98	Red_legged_sun_squirrel
23.09	14.36	10.99	0.85	Streaked_tenrec
76.79	35.09	30.74	22.46	Mongoose
17.11	10.87	8.02	0.54	Cyclops_leaf_nosed_bat
133.08	56.98	63.04	84.91	Capybara
36.54	21.55	16.43	4.66	Water_rat
72.70	36.84	35.00	24.01	water_chevrotain
78.37	57.84	49.03	99.45	Gibbon
34.08	20.41	14.08	3.23	Hammer_headed_fruit_bat
67.60	59.95	37.45	38.39	African_crested_porcupine
47.54	29.29	22.87	9.85	Zorilla
20.73	11.28	8.56	0.67	Long_eared_flying_squirrel
16.06	10.13	7.31	0.42	Zenkers_flying_squirrel
41.76	24.66	19.16	4.28	Short_nosed_bandicoot
64.81	38.62	27.34	17.28	Viscacha
20.54	13.34	7.75	0.60	Norway_lemming
62.35	36.55	27.99	20.24	Lemur
65.09	32.79	27.01	14.60	Brown_hare
58.45	30.84	25.73	13.05	Arctic_hare
86.67	56.04	37.26	54.62	Common_otter
76.59	56.59	44.39	64.67	Long_tailed_macaque
85.38	62.54	52.20	93.73	Barbary_macaque
98.86	47.55	53.30	64.78	Grey_kangaroo
89.57	51.95	47.71	49.25	Red_kangaroo
22.05	15.08	10.14	1.09	Elephant_shrew
52.76	28.63	22.75	6.19	Bilby
62.37	40.11	36.06	24.43	Salts_dikdik
50.98	34.43	24.87	11.23	Malayan_pangolin
46.38	32.55	22.74	10.56	Tree_pangolin
26.08	16.11	10.78	1.34	German_opposom
56.49	30.59	22.84	11.11	Alpine_marmott
58.54	34.60	26.06	17.45	Pine_marten
82.91	45.41	32.90	35.42	Fisher_martin
86.63	52.49	38.33	52.95	Badger
18.85	10.87	7.74	0.39	Common_vole
10.56	8.38	5.55	0.15	Pallas_mastiff_bat
14.78	9.96	7.77	0.40	Leach's_Single_Leaf_Bat
81.07	46.47	42.52	46.24	Muntjack
15.20	10.37	7.27	0.35	European_house_mouse
36.51	21.52	15.54	4.41	Stoat
30.75	17.43	12.79	2.44	Weasel
47.76	27.53	18.68	7.45	Polecat
61.61	32.43	24.39	14.21	Nutria
10.06	7.74	5.53	0.14	Natterers_bat
47.47	21.65	15.54	3.40	Numbat
214.43	60.30	44.93	90.29	Giant_anteater
85.17	61.89	48.42	96.62	Proboscis_monkey
75.02	43.24	34.97	31.31	Coati
11.56	10.00	6.27	0.24	African_noctule
44.81	29.68	23.35	9.01	Slow_loris

29.52	15.12	12.87	1.91	Degu
39.46	33.07	21.80	10.14	Platypus
116.81	60.29	41.61	93.11	Aardvark
62.59	28.45	25.55	10.86	Rabbit
230.21	111.32	106.00	618.82	South_american_sea_lion
92.60	51.50	45.50	61.07	Oribi
109.53	61.76	75.18	98.17	Sheep
126.37	95.65	83.38	369.27	Chimpanzee
103.97	76.88	62.57	164.20	Savanna_baboon
78.20	35.51	28.98	20.14	Asian_palm_civet
113.57	55.36	65.56	91.89	Collared_peccary
58.60	37.51	31.76	19.16	Cape_jumping_hare
40.97	22.52	18.15	3.79	Eastern_barred_bandicoot
47.39	31.40	22.98	11.60	Potto
36.12	20.03	14.74	3.68	Greater_glider
28.87	17.62	12.55	2.11	Sugar_glider
39.63	23.49	15.92	4.61	Gliding_phalanger
67.27	36.19	33.66	20.99	Yellow-footed_rock_wallaby
28.16	18.47	11.34	1.54	Tuan
86.46	37.53	30.73	20.14	Koala
123.14	95.18	68.06	270.19	Common_seal
12.94	8.52	5.34	0.15	Bat
131.37	103.46	95.66	456.72	Orangutan
30.19	19.17	13.35	2.90	Giant_otter_shrew
56.85	30.31	25.11	11.00	Rat_kangaroo
66.24	40.36	32.77	30.35	Kinkajou
77.20	53.23	45.77	68.40	Maroon_leaf_monkey
59.75	31.51	30.40	15.94	Rock_hyrax
73.12	47.11	34.06	38.66	Racoon
71.67	47.92	35.74	44.24	Diademed_sifaka
87.78	49.07	36.98	41.94	Aardwolf
40.35	23.85	18.20	4.52	Queensland_ringtail
39.68	21.96	18.00	4.42	Common_ringtail
48.16	24.27	18.45	6.48	Flying_fox
160.26	93.70	88.03	299.45	Reindeer
31.80	16.86	12.95	1.98	Common_rat
27.67	16.43	11.45	1.54	House_rat
50.41	29.20	20.53	9.56	Cream_coloured_giant_squirrel
54.96	30.62	19.80	10.91	Black_giant_squirrel
40.73	24.70	17.13	3.98	Checkered_elephant_shrew
64.74	41.76	29.09	12.09	Tasmanian_Devil
27.29	16.87	12.85	2.03	Kashmir_flying_squirrel
76.63	56.41	45.54	63.02	Leaf_monkey
16.20	10.27	6.50	0.30	Stripe-faced_dunnart
48.43	24.65	15.55	4.34	Solenadon
65.79	34.78	24.80	13.36	Spotted_cuscus
24.38	11.48	7.08	0.49	Musk_shrew
27.25	18.07	13.07	2.00	Slender_squirrel
47.52	31.29	23.02	10.59	Meerkat
207.58	82.99	90.04	227.39	Bearded_pig
125.76	68.74	75.39	142.29	Wild_boar
49.85	47.47	26.29	25.78	Short_nosed_echidna
22.66	16.17	12.85	1.46	East_african_mole_rat

```

22.30 15.69 9.20 0.86 European_mole
79.76 38.36 26.63 23.17 Southern_Tamandua
28.29 17.55 11.87 1.96 Eastern_chipmunk
206.48 98.53 122.39 369.78 Tapir
31.32 22.25 16.81 2.61 tarsier
129.48 66.22 76.62 167.16 White_lipped_peccary
43.80 21.11 15.93 2.27 Tail-less_tenrec
107.59 51.60 44.35 50.76 Tasmanian_wolf
66.24 31.63 31.22 14.29 Chevrotain
60.41 28.69 23.70 11.26 Bush_tailed_possum
31.16 18.44 13.79 2.11 Northern_tree_shrew
32.90 19.83 14.73 3.19 Tree_shrew
32.15 20.33 13.95 3.17 Painted_tree_shrew
200.23 98.99 84.53 358.82 Brown_bear
179.70 95.48 75.51 302.72 Sloth_bear
67.48 42.35 29.66 24.79 Ruffed_lemur
70.78 30.98 28.08 17.91 Rasse
67.05 54.15 44.99 56.71 Wombat
70.36 45.09 37.72 38.43 Arctic_fox
80.73 47.96 39.45 48.55 Fox
13.54 9.24 7.13 0.36 Meadow_jumping_mouse
13.15 9.05 7.00 NA Fossil_mouse
190.17 97.32 80.31 NA Fossil_bear
")

```

Apply transformations here

```

ECVdat <- transform(ECVdat,logV=log(Volume))
ECVdat <- transform(ECVdat,logL=log(Length))
ECVdat <- transform(ECVdat,logH=log(Height))
ECVdat <- transform(ECVdat,logW=log(Width))

```

Print data

```
ECVdat
```

##	Length	Width	Height	Volume	Common_name	logV
## 1	15.04	11.29	6.61	0.38	Pygmy_glider	-0.9675840
## 2	52.40	30.94	25.68	12.36	Rufous_kangaroo_rat	2.5144655
## 3	75.87	52.79	39.45	56.70	Howler_monkey	4.0377742
## 4	41.73	25.70	16.79	5.68	Scaley-tailed_squirrel	1.7369512
## 5	39.71	26.87	17.13	5.92	Lord_derby's_flying_squirrel	1.7783364
## 6	18.90	12.62	7.61	0.51	Yellow-footed_antechinus	-0.6733446
## 7	15.10	11.69	7.06	0.46	Brown_antechinus	-0.7765288
## 8	123.70	73.89	63.93	150.53	Pronghorn	5.0141624
## 9	46.75	28.70	18.45	6.51	Mountain_beaver	1.8733395
## 10	154.32	103.77	71.95	284.03	Antarctic_fur_seal	5.6490799
## 11	133.39	59.75	72.60	128.49	Babiroussa	4.8558511
## 12	49.43	29.61	24.27	9.49	Burrowing_bettong	2.2502386
## 13	61.51	32.76	27.05	16.43	Pale_throated_sloth	2.7991089
## 14	36.65	23.94	19.64	6.22	Common_marmoset	1.8277699
## 15	37.96	22.94	16.72	4.71	Plantain_squirrel	1.5496879
## 16	30.10	18.69	12.75	2.20	Bare_tailed_wooly_opossum	0.7884574
## 17	227.53	96.85	100.03	547.78	Dromedary_camel	6.3058737
## 18	87.04	52.86	45.46	66.40	Golden_jackal	4.1956971
## 19	98.73	59.43	53.36	91.65	Coyote	4.5179770

## 20	121.53	73.22	61.13	135.40	Wolf	4.9082334
## 21	120.81	68.38	62.67	151.03	Wild_goat	5.0174785
## 22	102.14	59.34	50.41	94.82	Roe_deer	4.5519804
## 23	51.14	21.72	18.46	6.31	Hutia	1.8421357
## 24	83.34	40.79	33.60	37.88	American_beaver	3.6344233
## 25	42.17	23.14	16.20	3.93	Guinea_pig	1.3686394
## 26	73.58	52.90	42.11	67.96	Capuchin	4.2189193
## 27	98.54	59.24	49.03	82.44	Common_duiker	4.4120708
## 28	74.43	57.25	44.83	72.19	Guenon	4.2793015
## 29	70.37	54.11	44.03	65.96	Mona_monkey	4.1890485
## 30	39.62	23.90	17.39	4.39	Chinchilla	1.4793292
## 31	26.37	22.97	13.25	2.30	Pink_fairy_armadillo	0.8329091
## 32	93.63	49.10	43.75	35.10	Two_toed_tree_sloth	3.5582011
## 33	93.24	41.11	36.58	36.65	African_civet_cat	3.6014134
## 34	30.63	17.31	13.42	1.67	European_hamster	0.5128236
## 35	126.62	117.09	81.10	376.40	Hooded_seal	5.9306524
## 36	11.69	9.82	5.47	0.22	Olivers_shrew	-1.5141277
## 37	159.07	82.94	80.42	164.22	Spotted_hyaena	5.1012070
## 38	28.23	17.47	13.22	2.37	Tuco-tuco	0.8628900
## 39	97.54	50.66	34.43	32.76	Paca	3.4892083
## 40	41.47	21.95	16.57	3.87	Prarie_dog	1.3532545
## 41	134.68	77.44	76.70	232.99	Fallow_deer	5.4509955
## 42	67.83	33.66	28.93	19.25	Golden_acouti	2.9575111
## 43	50.01	24.99	20.18	5.01	Southern_long_nosed_armadillo	1.6114359
## 44	62.29	30.57	25.52	11.45	Armadillo	2.4379897
## 45	43.00	23.88	16.47	4.28	Chuditch	1.4539530
## 46	53.27	27.81	21.63	8.45	Tiger_quoll	2.1341664
## 47	37.73	23.57	16.46	4.97	Quoll	1.6034198
## 48	70.40	44.74	38.94	40.26	Aye-aye	3.6953584
## 49	80.18	34.10	33.94	22.45	Tree_hyrax	3.1112906
## 50	18.20	12.87	10.06	0.87	Vampire_bat	-0.1392621
## 51	51.10	25.83	20.13	6.02	American_opossum	1.7950873
## 52	22.16	16.88	12.42	1.53	Ord's_kangaroo_rat	0.4252677
## 53	159.31	116.10	111.67	418.77	Dugong	6.0373218
## 54	36.02	20.18	14.76	3.47	Equatorial_fruit_bat	1.2441546
## 55	109.38	79.78	48.74	127.26	Sea_otter	4.8462322
## 56	282.83	95.88	99.82	503.33	Horse	6.2212460
## 57	59.41	35.67	28.44	20.54	New_world_porcupine	3.0223742
## 58	36.22	23.15	15.16	3.27	Hedgehog	1.1847900
## 59	35.65	23.67	17.13	4.99	Galago	1.6074359
## 60	128.38	72.40	57.86	133.05	Puma	4.8907250
## 61	173.29	100.56	80.01	225.29	Lion	5.4173885
## 62	100.81	59.32	48.56	83.41	Lynx	4.4237682
## 63	76.86	47.30	36.21	41.07	Wild_cat	3.7152779
## 64	35.01	23.69	17.80	4.55	Allens_bushbaby	1.5151272
## 65	26.63	18.83	14.09	3.01	Demidoffs_bushbaby	1.1019401
## 66	42.06	25.63	16.80	5.61	Philippine_flying_lemur	1.7245507
## 67	95.40	56.17	50.88	76.72	Dorcas_gazelle	4.3401624
## 68	160.80	101.21	93.39	482.16	Western_gorilla	6.1782760
## 69	23.92	16.09	10.91	1.61	Huets_dormouse	0.4762342
## 70	104.47	67.64	44.41	80.51	Wolverine	4.3883814
## 71	38.37	23.24	16.73	4.98	Red_legged_sun_squirrel	1.6054299
## 72	23.09	14.36	10.99	0.85	Streaked_tenrec	-0.1625189
## 73	76.79	35.09	30.74	22.46	Mongoose	3.1117359

## 74	17.11	10.87	8.02	0.54	Cyclops_leaf_nosed_bat	-0.6161861
## 75	133.08	56.98	63.04	84.91	Capybara	4.4415919
## 76	36.54	21.55	16.43	4.66	Water_rat	1.5390154
## 77	72.70	36.84	35.00	24.01	water_chevrotain	3.1784704
## 78	78.37	57.84	49.03	99.45	Gibbon	4.5996550
## 79	34.08	20.41	14.08	3.23	Hammer_headed_fruit_bat	1.1724821
## 80	67.60	59.95	37.45	38.39	African_crested_porcupine	3.6477970
## 81	47.54	29.29	22.87	9.85	Zorilla	2.2874715
## 82	20.73	11.28	8.56	0.67	Long_eared_flying_squirrel	-0.4004776
## 83	16.06	10.13	7.31	0.42	Zenkers_flying_squirrel	-0.8675006
## 84	41.76	24.66	19.16	4.28	Short_nosed_bandicoot	1.4539530
## 85	64.81	38.62	27.34	17.28	Viscacha	2.8495498
## 86	20.54	13.34	7.75	0.60	Norway_lemming	-0.5108256
## 87	62.35	36.55	27.99	20.24	Lemur	3.0076608
## 88	65.09	32.79	27.01	14.60	Brown_hare	2.6810215
## 89	58.45	30.84	25.73	13.05	Arctic_hare	2.5687881
## 90	86.67	56.04	37.26	54.62	Common_otter	4.0004001
## 91	76.59	56.59	44.39	64.67	Long_tailed_macaque	4.1692974
## 92	85.38	62.54	52.20	93.73	Barbary_macaque	4.5404183
## 93	98.86	47.55	53.30	64.78	Grey_kangaroo	4.1709969
## 94	89.57	51.95	47.71	49.25	Red_kangaroo	3.8969094
## 95	22.05	15.08	10.14	1.09	Elephant_shrew	0.0861777
## 96	52.76	28.63	22.75	6.19	Bilby	1.8229351
## 97	62.37	40.11	36.06	24.43	Salts_dikdik	3.1958119
## 98	50.98	34.43	24.87	11.23	Malayan_pangolin	2.4185888
## 99	46.38	32.55	22.74	10.56	Tree_pangolin	2.3570733
## 100	26.08	16.11	10.78	1.34	German_opposom	0.2926696
## 101	56.49	30.59	22.84	11.11	Alpine_marmott	2.4078456
## 102	58.54	34.60	26.06	17.45	Pine_marten	2.8593396
## 103	82.91	45.41	32.90	35.42	Fisher_martin	3.5672766
## 104	86.63	52.49	38.33	52.95	Badger	3.9693481
## 105	18.85	10.87	7.74	0.39	Common_vole	-0.9416085
## 106	10.56	8.38	5.55	0.15	Pallas_mastiff_bat	-1.8971200
## 107	14.78	9.96	7.77	0.40	Leach's_Single_Leaf_Bat	-0.9162907
## 108	81.07	46.47	42.52	46.24	Muntjack	3.8338452
## 109	15.20	10.37	7.27	0.35	European_house_mouse	-1.0498221
## 110	36.51	21.52	15.54	4.41	Stoat	1.4838747
## 111	30.75	17.43	12.79	2.44	Weasel	0.8919980
## 112	47.76	27.53	18.68	7.45	Polecat	2.0082140
## 113	61.61	32.43	24.39	14.21	Nutria	2.6539459
## 114	10.06	7.74	5.53	0.14	Natterers_bat	-1.9661129
## 115	47.47	21.65	15.54	3.40	Numbat	1.2237754
## 116	214.43	60.30	44.93	90.29	Giant_anteater	4.5030267
## 117	85.17	61.89	48.42	96.62	Proboscis_monkey	4.5707858
## 118	75.02	43.24	34.97	31.31	Coati	3.4439375
## 119	11.56	10.00	6.27	0.24	African_noctule	-1.4271164
## 120	44.81	29.68	23.35	9.01	Slow_loris	2.1983351
## 121	29.52	15.12	12.87	1.91	Degu	0.6471032
## 122	39.46	33.07	21.80	10.14	Platypus	2.3164880
## 123	116.81	60.29	41.61	93.11	Aardvark	4.5337816
## 124	62.59	28.45	25.55	10.86	Rabbit	2.3850863
## 125	230.21	111.32	106.00	618.82	South_american_sea_lion	6.4278144
## 126	92.60	51.50	45.50	61.07	Oribi	4.1120207
## 127	109.53	61.76	75.18	98.17	Sheep	4.5867007

## 128	126.37	95.65	83.38	369.27	Chimpanzee	5.9115281
## 129	103.97	76.88	62.57	164.20	Savanna_baboon	5.1010852
## 130	78.20	35.51	28.98	20.14	Asian_palm_civet	3.0027079
## 131	113.57	55.36	65.56	91.89	Collared_peccary	4.5205922
## 132	58.60	37.51	31.76	19.16	Cape_jumping_hare	2.9528248
## 133	40.97	22.52	18.15	3.79	Eastern_barred_bandicoot	1.3323660
## 134	47.39	31.40	22.98	11.60	Potto	2.4510051
## 135	36.12	20.03	14.74	3.68	Greater_glider	1.3029128
## 136	28.87	17.62	12.55	2.11	Sugar_glider	0.7466879
## 137	39.63	23.49	15.92	4.61	Gliding_phalanger	1.5282279
## 138	67.27	36.19	33.66	20.99	Yellow-footed_rock_wallaby	3.0440461
## 139	28.16	18.47	11.34	1.54	Tuan	0.4317824
## 140	86.46	37.53	30.73	20.14	Koala	3.0027079
## 141	123.14	95.18	68.06	270.19	Common_seal	5.5991254
## 142	12.94	8.52	5.34	0.15	Bat	-1.8971200
## 143	131.37	103.46	95.66	456.72	Orangutan	6.1240705
## 144	30.19	19.17	13.35	2.90	Giant_otter_shrew	1.0647107
## 145	56.85	30.31	25.11	11.00	Rat_kangaroo	2.3978953
## 146	66.24	40.36	32.77	30.35	Kinkajou	3.4127965
## 147	77.20	53.23	45.77	68.40	Maroon_leaf_monkey	4.2253728
## 148	59.75	31.51	30.40	15.94	Rock_hyrax	2.7688317
## 149	73.12	47.11	34.06	38.66	Racoon	3.6548055
## 150	71.67	47.92	35.74	44.24	Diademed_sifaka	3.7896294
## 151	87.78	49.07	36.98	41.94	Aardwolf	3.7362400
## 152	40.35	23.85	18.20	4.52	Queensland_ringtail	1.5085120
## 153	39.68	21.96	18.00	4.42	Common_ringtail	1.4861397
## 154	48.16	24.27	18.45	6.48	Flying_fox	1.8687205
## 155	160.26	93.70	88.03	299.45	Reindeer	5.7019475
## 156	31.80	16.86	12.95	1.98	Common_rat	0.6830968
## 157	27.67	16.43	11.45	1.54	House_rat	0.4317824
## 158	50.41	29.20	20.53	9.56	Cream_coloured_giant_squirrel	2.2575877
## 159	54.96	30.62	19.80	10.91	Black_giant_squirrel	2.3896798
## 160	40.73	24.70	17.13	3.98	Checkered_elephant_shrew	1.3812818
## 161	64.74	41.76	29.09	12.09	Tasmanian_Devil	2.4923787
## 162	27.29	16.87	12.85	2.03	Kashmir_flying_squirrel	0.7080358
## 163	76.63	56.41	45.54	63.02	Leaf_monkey	4.1434521
## 164	16.20	10.27	6.50	0.30	Stripe-faced_dunnart	-1.2039728
## 165	48.43	24.65	15.55	4.34	Solenadon	1.4678743
## 166	65.79	34.78	24.80	13.36	Spotted_cuscus	2.5922652
## 167	24.38	11.48	7.08	0.49	Musk_shrew	-0.7133499
## 168	27.25	18.07	13.07	2.00	Slender_squirrel	0.6931472
## 169	47.52	31.29	23.02	10.59	Meerkat	2.3599102
## 170	207.58	82.99	90.04	227.39	Bearded_pig	5.4266666
## 171	125.76	68.74	75.39	142.29	Wild_boar	4.9578672
## 172	49.85	47.47	26.29	25.78	Short_nosed_echidna	3.2495990
## 173	22.66	16.17	12.85	1.46	East_african_mole_rat	0.3784364
## 174	22.30	15.69	9.20	0.86	European_mole	-0.1508229
## 175	79.76	38.36	26.63	23.17	Southern_Tamandua	3.1428583
## 176	28.29	17.55	11.87	1.96	Eastern_chipmunk	0.6729445
## 177	206.48	98.53	122.39	369.78	Tapir	5.9129082
## 178	31.32	22.25	16.81	2.61	tarsier	0.9593502
## 179	129.48	66.22	76.62	167.16	White_lipped_peccary	5.1189514
## 180	43.80	21.11	15.93	2.27	Tail-less_tenrec	0.8197798
## 181	107.59	51.60	44.35	50.76	Tasmanian_wolf	3.9271086


```

## 182 66.24 31.63 31.22 14.29
## 183 60.41 28.69 23.70 11.26
## 184 31.16 18.44 13.79 2.11
## 185 32.90 19.83 14.73 3.19
## 186 32.15 20.33 13.95 3.17
## 187 200.23 98.99 84.53 358.82
## 188 179.70 95.48 75.51 302.72
## 189 67.48 42.35 29.66 24.79
## 190 70.78 30.98 28.08 17.91
## 191 67.05 54.15 44.99 56.71
## 192 70.36 45.09 37.72 38.43
## 193 80.73 47.96 39.45 48.55
## 194 13.54 9.24 7.13 0.36
## 195 13.15 9.05 7.00 NA
## 196 190.17 97.32 80.31 NA
##      logL      logH      logW
## 1  2.710713 1.888584 2.423917
## 2  3.958907 3.245712 3.432050
## 3  4.329021 3.675034 3.966322
## 4  3.731220 2.820783 3.246491
## 5  3.681603 2.840831 3.291010
## 6  2.939162 2.029463 2.535283
## 7  2.714695 1.954445 2.458734
## 8  4.817859 4.157789 4.302578
## 9  3.844814 2.915064 3.356897
## 10 5.039028 4.275971 4.642177
## 11 4.893277 4.284965 4.090169
## 12 3.900558 3.189241 3.388112
## 13 4.119200 3.297687 3.489208
## 14 3.601413 2.977568 3.175551
## 15 3.636533 2.816606 3.132882
## 16 3.404525 2.545531 2.927989
## 17 5.427282 4.605470 4.573163
## 18 4.466368 3.816833 3.967647
## 19 4.592389 3.977061 4.084799
## 20 4.800161 4.113003 4.293469
## 21 4.794219 4.137883 4.225080
## 22 4.626344 3.920190 4.083284
## 23 3.934567 2.915606 3.078233
## 24 4.422929 3.514526 3.708437
## 25 3.741709 2.785011 3.141563
## 26 4.298373 3.740285 3.968403
## 27 4.590463 3.892432 4.081597
## 28 4.309859 3.802878 4.047428
## 29 4.253767 3.784871 3.991019
## 30 3.679334 2.855895 3.173878
## 31 3.272227 2.583998 3.134189
## 32 4.539351 3.778492 3.893859
## 33 4.535177 3.599502 3.716251
## 34 3.421980 2.596746 2.851284
## 35 4.841190 4.395683 4.762943
## 36 2.458734 1.699279 2.284421
## 37 5.069344 4.387263 4.418117
## 38 3.340385 2.581731 2.860485

```

```

      Chevrotain 2.6595600
      Bush_tailed_possum 2.4212566
      Northern_tree_shrew 0.7466879
      Tree_shrew 1.1600209
      Painted_tree_shrew 1.1537316
      Brown_bear 5.8828209
      Sloth_bear 5.7128083
      Ruffled_lemur 3.2104403
      Rasse 2.8853592
      Wombat 4.0379506
      Arctic_fox 3.6488384
      Fox 3.8825942
      Meadow_jumping_mouse -1.0216512
      Fossil_mouse NA
      Fossil_bear NA

```

```

## 39 4.580263 3.538928 3.925137
## 40 3.724970 2.807594 3.088767
## 41 4.902902 4.339902 4.349503
## 42 4.217005 3.364879 3.516310
## 43 3.912223 3.004692 3.218476
## 44 4.131801 3.239462 3.420019
## 45 3.761200 2.801541 3.173041
## 46 3.975373 3.074081 3.325396
## 47 3.630456 2.800933 3.159975
## 48 4.254193 3.662022 3.800868
## 49 4.384274 3.524594 3.529297
## 50 2.901422 2.308567 2.554899
## 51 3.933784 3.002211 3.251537
## 52 3.098289 2.519308 2.826129
## 53 5.070852 4.715548 4.754452
## 54 3.584074 2.691921 3.004692
## 55 4.694828 3.886500 4.379273
## 56 5.644846 4.603369 4.563097
## 57 4.084463 3.347797 3.574310
## 58 3.589611 2.718660 3.141995
## 59 3.573749 2.840831 3.164208
## 60 4.854995 4.058026 4.282206
## 61 5.154966 4.382152 4.610755
## 62 4.613238 3.882800 4.082947
## 63 4.341986 3.589335 3.856510
## 64 3.555634 2.879198 3.165053
## 65 3.282038 2.645465 2.935451
## 66 3.739097 2.821379 3.243764
## 67 4.558079 3.929470 4.028383
## 68 5.080161 4.536784 4.617198
## 69 3.174715 2.389680 2.778198
## 70 4.648900 3.793465 4.214200
## 71 3.647276 2.817204 3.145875
## 72 3.139400 2.396986 2.664447
## 73 4.341074 3.425565 3.557916
## 74 2.839663 2.081938 2.386007
## 75 4.890950 4.143769 4.042700
## 76 3.598408 2.799109 3.070376
## 77 4.286341 3.555348 3.606584
## 78 4.361441 3.892432 4.057681
## 79 3.528711 2.644755 3.016025
## 80 4.213608 3.623007 4.093511
## 81 3.861571 3.129826 3.377246
## 82 3.031582 2.147100 2.423031
## 83 2.776332 1.989243 2.315501
## 84 3.731939 2.952825 3.205182
## 85 4.171460 3.308351 3.653770
## 86 3.022374 2.047693 2.590767
## 87 4.132764 3.331847 3.598681
## 88 4.175771 3.296207 3.490124
## 89 4.068172 3.247658 3.428813
## 90 4.462108 3.617920 4.026066
## 91 4.338467 3.793014 4.035832
## 92 4.447112 3.955082 4.135806

```

93 4.593705 3.975936 3.861782
94 4.495020 3.865141 3.950282
95 3.093313 2.316488 2.713369
96 3.965753 3.124565 3.354455
97 4.133084 3.585184 3.691626
98 3.931433 3.213662 3.538928
99 3.836868 3.124125 3.482777
100 3.261169 2.377693 2.779440
101 4.034064 3.128513 3.420673
102 4.069710 3.260402 3.543854
103 4.417756 3.493473 3.815732
104 4.461646 3.646233 3.960623
105 2.936513 2.046402 2.386007
106 2.357073 1.713798 2.125848
107 2.693275 2.050270 2.298577
108 4.395313 3.749975 3.838807
109 2.721295 1.983756 2.338917
110 3.597586 2.743417 3.068983
111 3.425890 2.548664 2.858193
112 3.866188 2.927453 3.315276
113 4.120824 3.194173 3.479084
114 2.308567 1.710188 2.046402
115 3.860098 2.743417 3.075005
116 5.367983 3.805106 4.099332
117 4.444649 3.879913 4.125359
118 4.317755 3.554491 3.766766
119 2.447551 1.835776 2.302585
120 3.802431 3.150597 3.390473
121 3.385068 2.554899 2.716018
122 3.675288 3.081910 3.498627
123 4.760549 3.728341 4.099166
124 4.136606 3.240637 3.348148
125 5.438992 4.663439 4.712409
126 4.528289 3.817712 3.941582
127 4.696198 4.319885 4.123256
128 4.839214 4.423408 4.560696
129 4.644102 4.136286 4.342246
130 4.359270 3.366606 3.569814
131 4.732419 4.182966 4.013857
132 4.070735 3.458208 3.624608
133 3.712840 2.898671 3.114404
134 3.858411 3.134624 3.446808
135 3.586847 2.690565 2.997231
136 3.362803 2.529721 2.869035
137 3.679586 2.767576 3.156575
138 4.208714 3.516310 3.588783
139 3.337903 2.428336 2.916148
140 4.459682 3.425239 3.625141
141 4.813322 4.220390 4.555770
142 2.560323 1.675226 2.142416
143 4.878018 4.560800 4.639185
144 3.407511 2.591516 2.953347
145 4.040416 3.223266 3.411478
146 4.193285 3.489513 3.697839

```
## 147 4.346399 3.823629 3.974622
## 148 4.090169 3.414443 3.450305
## 149 4.292102 3.528124 3.852485
## 150 4.272072 3.576271 3.869533
## 151 4.474834 3.610377 3.893248
## 152 3.697591 2.901422 3.171784
## 153 3.680847 2.890372 3.089223
## 154 3.874529 2.915064 3.189241
## 155 5.076797 4.477678 4.540098
## 156 3.459466 2.561096 2.824944
## 157 3.320349 2.437990 2.799109
## 158 3.920190 3.021887 3.374169
## 159 4.006606 2.985682 3.421653
## 160 3.706965 2.840831 3.206803
## 161 4.170379 3.370394 3.731939
## 162 3.306520 2.553344 2.825537
## 163 4.338989 3.818591 4.032646
## 164 2.785011 1.871802 2.329227
## 165 3.880119 2.744061 3.204777
## 166 4.186468 3.210844 3.549043
## 167 3.193763 1.957274 2.440606
## 168 3.305054 2.570320 2.894253
## 169 3.861151 3.136363 3.443299
## 170 5.335517 4.500254 4.418720
## 171 4.834375 4.322675 4.230331
## 172 3.909018 3.269189 3.860098
## 173 3.120601 2.553344 2.783158
## 174 3.104587 2.219203 2.753024
## 175 4.379022 3.282038 3.647015
## 176 3.342508 2.474014 2.865054
## 177 5.330204 4.807213 4.590361
## 178 3.444257 2.821974 3.102342
## 179 4.863526 4.338858 4.192983
## 180 3.779634 2.768204 3.049747
## 181 4.678328 3.792113 3.943522
## 182 4.193285 3.441059 3.454106
## 183 4.101155 3.165475 3.356549
## 184 3.439135 2.623944 2.914522
## 185 3.493473 2.689886 2.987196
## 186 3.470412 2.635480 3.012098
## 187 5.299467 4.437107 4.595019
## 188 5.191289 4.324265 4.558917
## 189 4.211831 3.389799 3.745968
## 190 4.259576 3.335058 3.433342
## 191 4.205439 3.806440 3.991758
## 192 4.253625 3.630190 3.808660
## 193 4.391110 3.675034 3.870367
## 194 2.605648 1.964311 2.223542
## 195 2.576422 1.945910 2.202765
## 196 5.247918 4.385894 4.578005
```

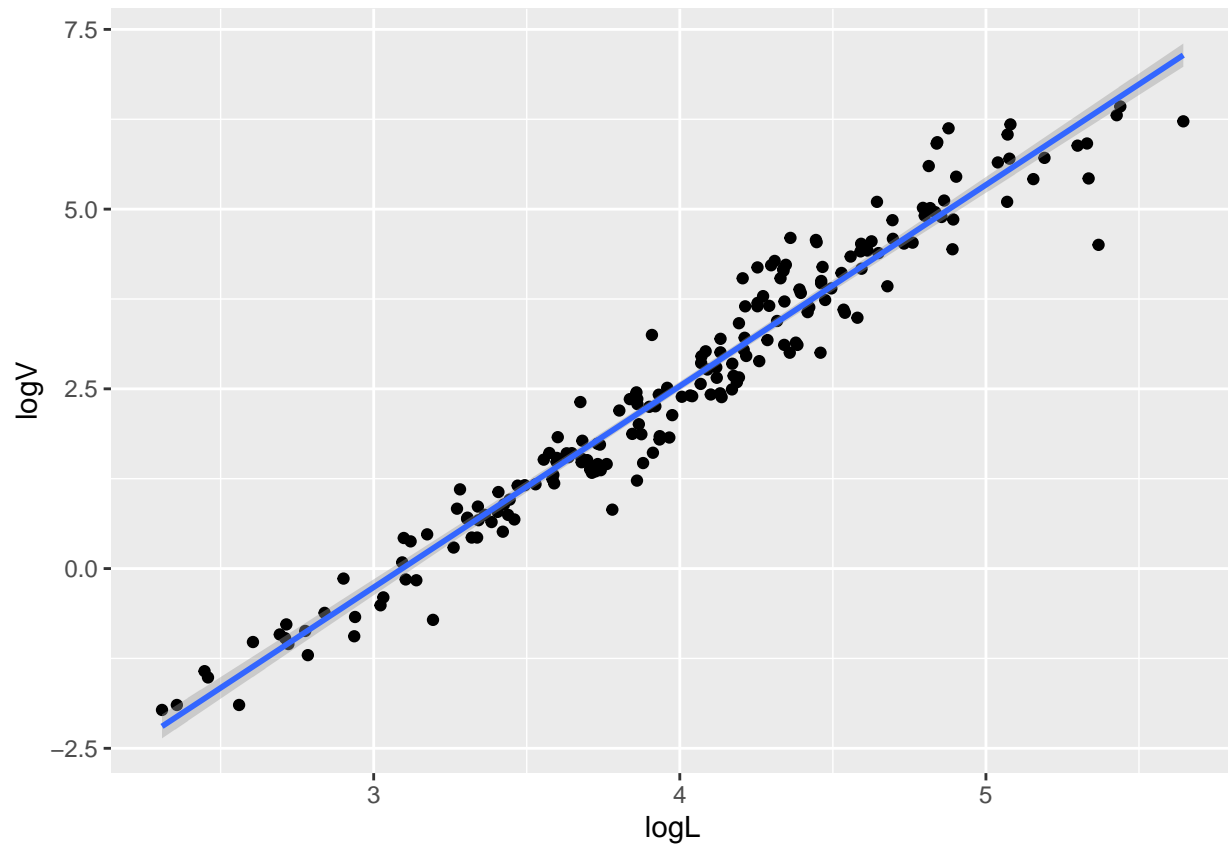
```
# Graphics using ggplot2
ggplot(ECVdat,aes(logL,logV))+
  geom_point()+
```

```
stat_smooth(method="lm")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 2 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_point()`).
```

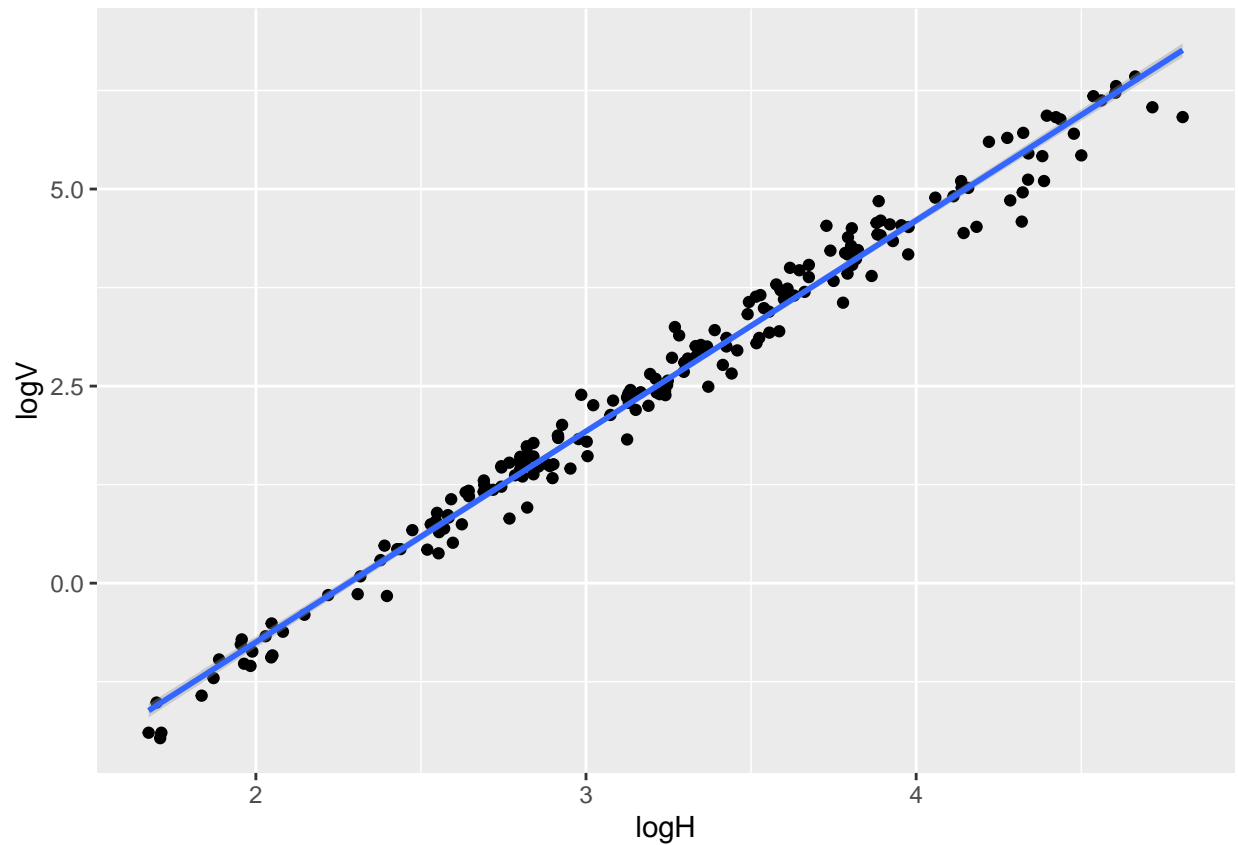


```
ggplot(ECVdat, aes(logH, logV)) +  
  geom_point() +  
  stat_smooth(method="lm")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 2 rows containing non-finite values (`stat_smooth()`).
```

```
## Removed 2 rows containing missing values (`geom_point()`).
```

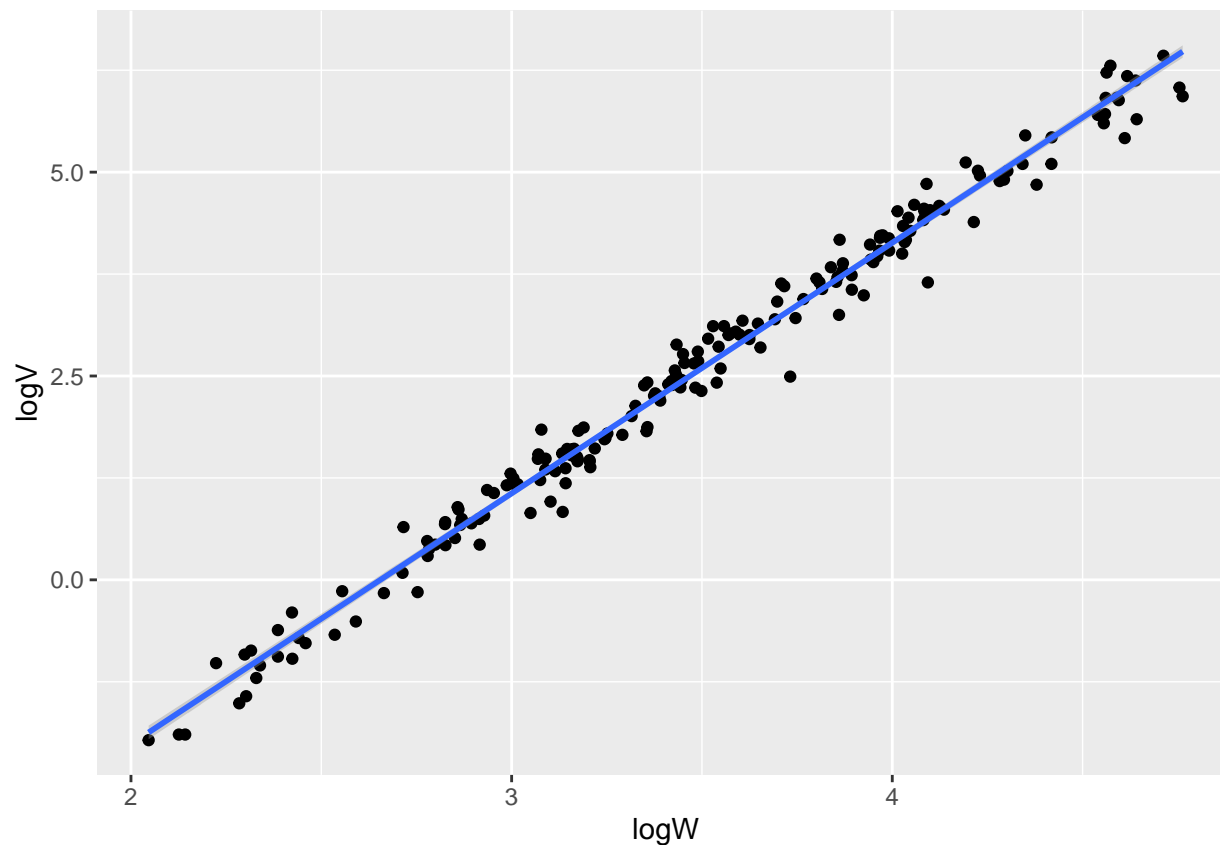


```
ggplot(ECVdat,aes(logW,logV))+  
  geom_point()+  
  stat_smooth(method="lm")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 2 rows containing non-finite values (`stat_smooth()`).
```

```
## Removed 2 rows containing missing values (`geom_point()`).
```



```
# Multiple regression analysis with model selection
```

```
regout <- lm(logV~logL+logH+logW,data=ECVdat,na.action="na.omit")
summary(regout)
```

```
##
## Call:
## lm(formula = logV ~ logL + logH + logW, data = ECVdat, na.action = "na.omit")
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.64179 -0.09442  0.03152  0.12186  0.34807
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -7.53834    0.11721  -64.314  < 2e-16 ***
## logL           0.30204    0.08006   3.773 0.000216 ***
## logH           1.04500    0.10939   9.553  < 2e-16 ***
## logW           1.57849    0.11190  14.107  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1708 on 190 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.9926, Adjusted R-squared:  0.9925
## F-statistic: 8490 on 3 and 190 DF, p-value: < 2.2e-16
```

```
# 95% confidence intervals for regression coefficients  
confint(regout)
```

```
##           2.5 %      97.5 %  
## (Intercept) -7.7695396 -7.3071358  
## logL        0.1441156  0.4599598  
## logH        0.8292231  1.2607743  
## logW        1.3577725  1.7992098
```

```
# Standardized regression coefficients  
lm.beta(regout)
```

```
##      logL      logH      logW  
## 0.1052216 0.3873106 0.5097404
```

```
# Tolerance values (1/vif)  
tol <- 1/vif(regout)  
tol
```

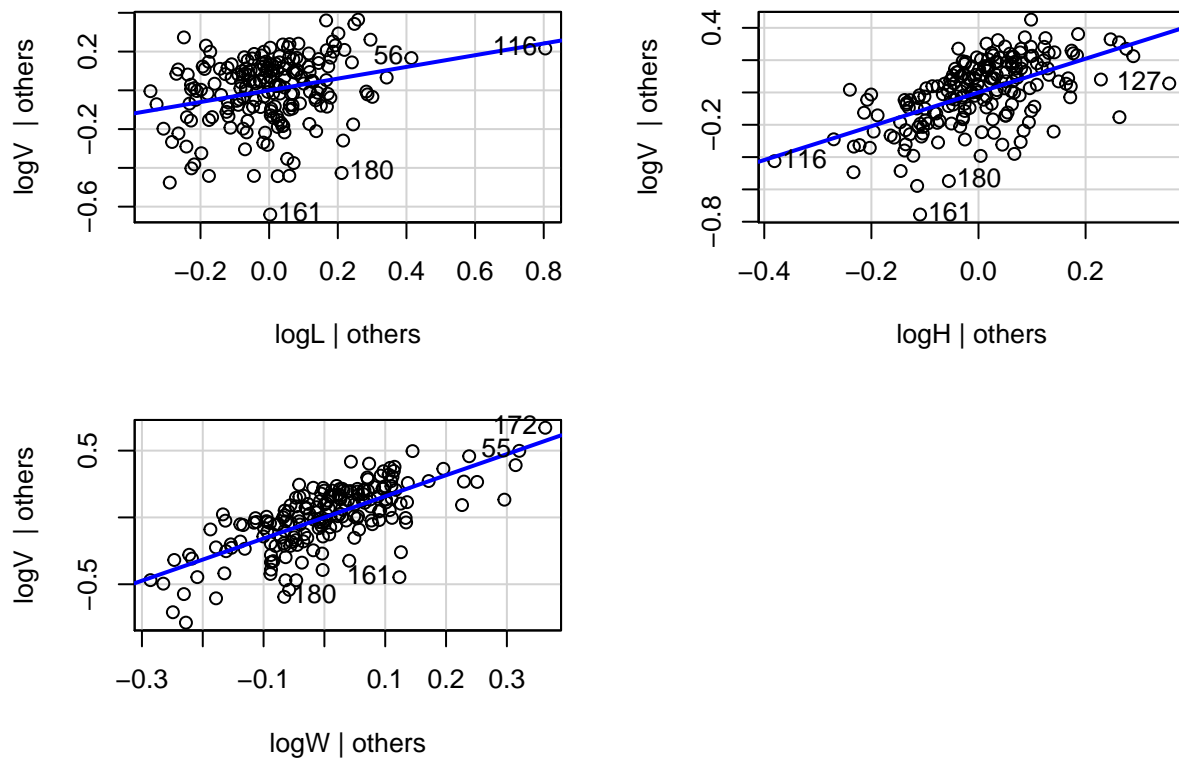
```
##      logL      logH      logW  
## 0.05009829 0.02370850 0.02984724
```

```
# Variance inflation factors  
vif(regout)
```

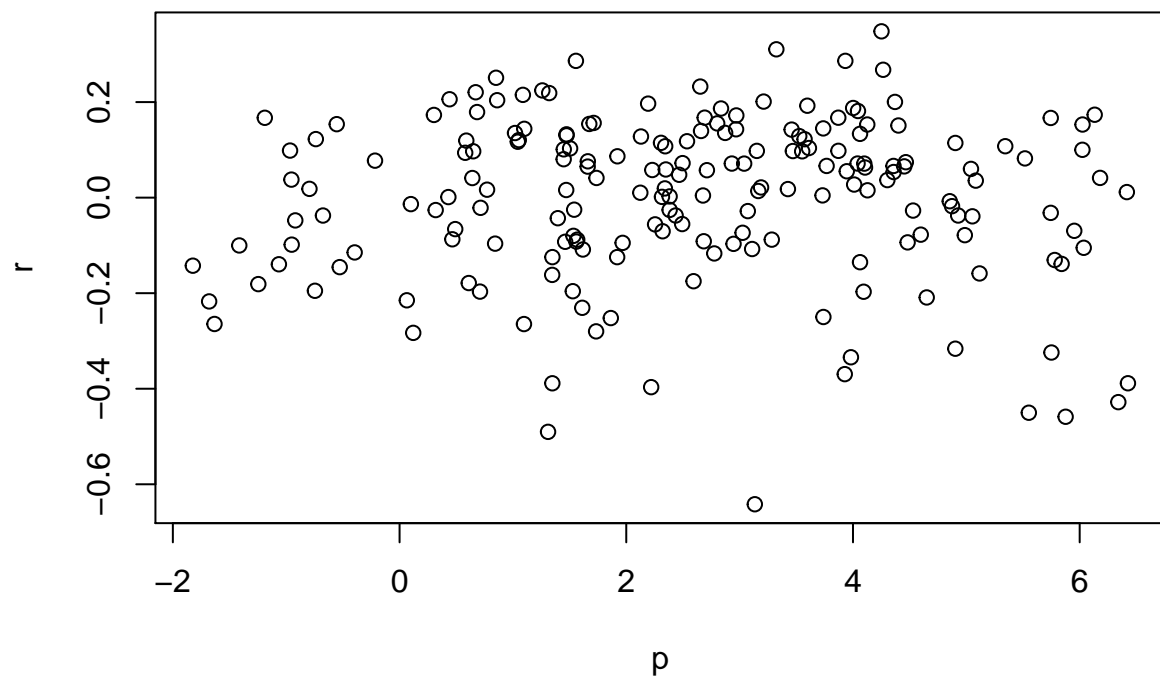
```
##      logL      logH      logW  
## 19.96076 42.17897 33.50393
```

```
# Residual-residual plots  
avPlots(regout)
```


Added-Variable Plots

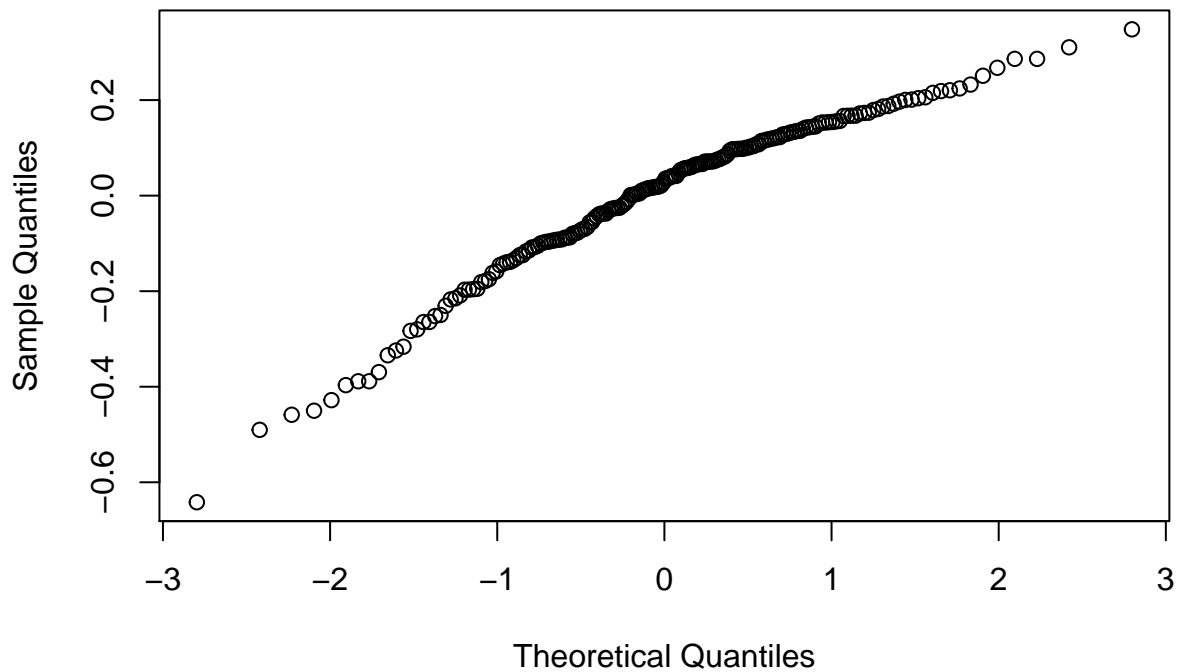


```
# Diagnostic plots to check regression assumptions
p <- predict(regout)
r <- resid(regout)
plot(p,r)
```



`qqnorm(r)`

Normal Q-Q Plot



```
# New data points
newdata <- read.table(header=T,colClasses=c(rep("numeric",3)),text="
Length Width Height
13.15 9.05 7.00
190.17 97.32 80.31
")

# Need to transform values as above
newdata <- transform(newdata,logL=log(Length))
newdata <- transform(newdata,logW=log(Width))
newdata <- transform(newdata,logH=log(Height))

# Print new data
newdata

## Length Width Height logL logW logH
## 1 13.15 9.05 7.00 2.576422 2.202765 1.945910
## 2 190.17 97.32 80.31 5.247918 4.578005 4.385894

# Confidence interval for new data
predict(regout,newdata,interval="confidence")

## fit lwr upr
## 1 -1.249643 -1.319570 -1.179715
## 2 5.856325 5.799914 5.912736

# Prediction interval for new data
predict(regout,newdata,interval="prediction")
```

##		fit	lwr	upr
## 1	-1.249643	-1.593664	-0.9056216	
## 2	5.856325	5.514795	6.1978553	