Florida Scrub Millipede (*Floridobolus penneri*) and North American Millipede (*Narceus americanus*) Burrow Casts

Principle Investigator: Jared Bowen
Project Duration: 2011 – 2013

Florida Scrub Millipede (*F. penneri*)

Note: Burrow casts are marked FB, but FB = FP

Total Burrows: 42

Subvertical Shafts (22)
FP2C, FP3C, FP3D, FP3E, FP3F, FP3G, FP3H, FP3I, FP2E, FP2F, FP2G, FP6A, FP3A, FP5B, FP5C, FP5D, FP7A, FP7C, FP7E, FP7F, FP7H, FP5E

Vertical Shafts (9)
FP3B, FP2A, FP2B, FP2D, FP4A, FP5A, FP7B, FP2M, FP7D

J-Shaped Burrows (6)
FP2I, FP2J, FP2K, FP2L, FP7G, FP2H

Helical Burrows (2)
FP4B, FP1

O-Shaped BurrowS (3)
Ob(T1), Oc(T1), Ob(T2)

North American Millipede (*N. americanus*)

Note: Burrow casts are marked OS, but OS = NA

Total Burrows: 29

Vertical Shafts (7)
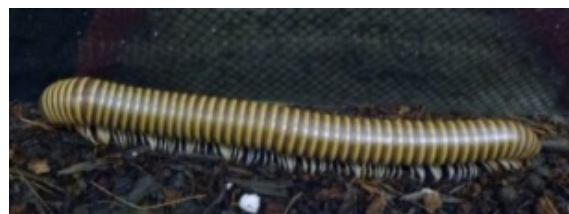NA28, NA29C, NA30A, NA30C, NA33A, NA33B, NA30F

Subvertical Shafts (13)
NA32, NA23, NA25A, NA21A, NA21B, NA21C, NA30B, NA30D, NA21D, NA24, NA21E, NA26A, NA30E

Helical Burrows (5)
NA1, NA25B, NA33C, NA29B, NA21F

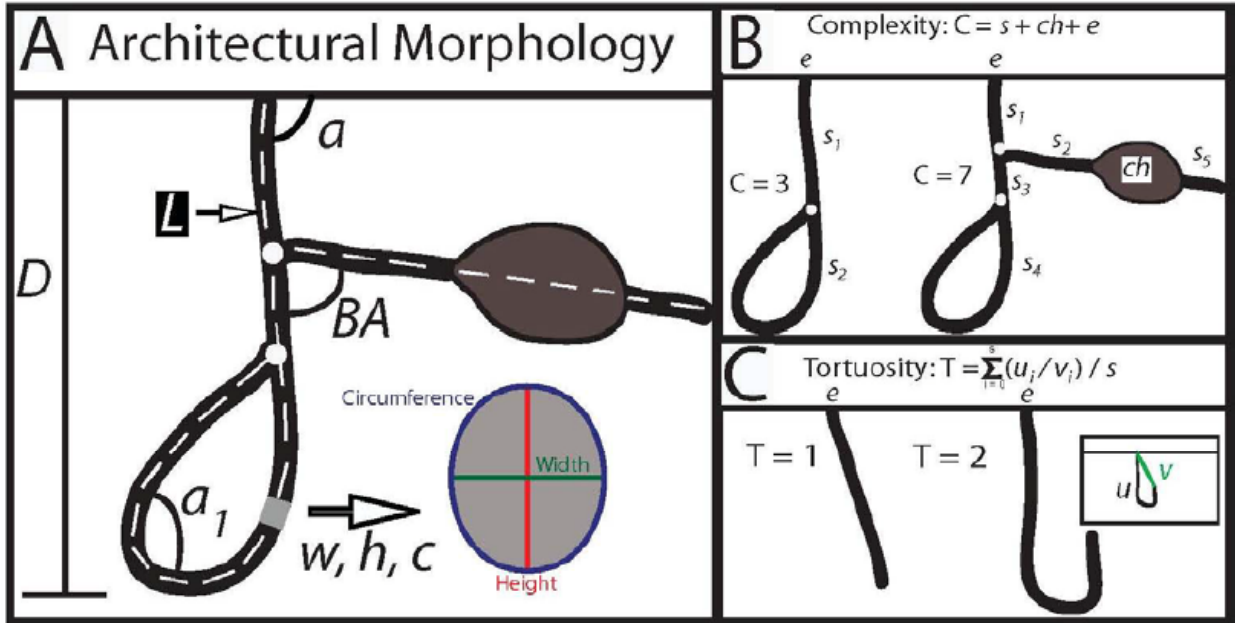*O-Shaped Burrows (4)*
NA29A, NA26B, NA31A NA31B

Other Burrows: Florida Blue Centipede (*Scolopendra viridis*)

Data not collected on these casts: SV4, SV5, SV6, SV7

Bags of Burrow Casts

Bag #	Casts Contained	Architecture
1	FP2C, FP3C, FP3D, FP3E, FP3F, FP3G, FP3H, FP3I, FP23, FP2F, FP2G, FP6A, FP3A, FP5B, FP5C, FP5D, FP7A, FP7C, FP7E, FP7F, FP7H, FP5E	SS
2	FP3B, FP2A, FP2B, FP2D, FP4A, FP5A, FP7B, FP2M, FP7D	VS
3	FP2A, FP2J, FP2K, FP7G, FP2H, FP2L	JS
	FP4B, FP1	HB
	FP5F, FP6B, FP5G	OS
4	NA32, NA23, NA25A, NA21A, NA21B, NA21C, NA30B, NA30D, NA21D, NA24, NA21E, NA26A, NA30E	SS
5	NA28, NA29C, NA30A, NA30C, NA33A, NA33B, NA30F,	VS
	NA1, NA25B, NA33C, NA29B, NA21F	HB
	NA29A, NA26B, NA31A, NA31B	OS
6	SV1, SV2, SV3, SV4, SV5, SV6, SV7, SV8	
7	Other *N. americanus* and *F. penneri* burrows	

Burrow Measurements

A. Architectural Morphology

B. Complexity: $C = s + ch + e$

$C = 3$

$C = 7$

C. Tortuosity: $T = \sum_{i=0}^{s}(u_i/v_i)/s$

$T = 1$

$T = 2$

Experimental Setup

Experiment 1: Basic Morphology

Species	Specimens	Tank Size	Sediment	Depth	% Moisture	Duration	Burrow #s	Burrow Architectures
N. americanus	5	30	50/50 (F/Soil)	20	37%	7 (12)	OS 26 A-B	Sub V, O (T1)
N. americanus	5	65	50/50 (F/Soil)	45	32%	7 (12)	OS 23	Sub V
N. americanus	1	30	50/50 (F/Soil)	20	35%	7(8)	No Burrow	None
N. americanus	1	30	50/50 (F/Soil)	20	30%	7(8)	OS 24	Sub VC
N. americanus	1	65	50/50 (F/Soil)	45	40%	7(7)	OS 28	V
N. americanus	5	30	50/50 (F/Soil)	20	35%	14(21)	OS 25 A-B	Sub V, H
N. americanus	5	65	50/50 (F/Soil)	43	37%	14(14)	OS 21 A-F	Sub V, Sub VB, Sub VC, HC
N. americanus	1	30	50/50 (F/Soil)	20	35%	14(14)	OS 1	H
N. americanus	1	65	50/50 (F/Soil)	45	35%	14(19)	No Burrow	None

Experiment 2: Substrate Composition

Species	Specimens	Tank Size	Sediment	Depth	% Moisture	Duration	Burrow #s	Burrow Architectures
F. penneri	5	30	50/50 (Sa/Soil)	16	50%	14(94)	FB 6 A-E	Sub V, OC (T1)
F. penneri	5	65	100% Soil	39	54%	7(8)	FB 7 A-H	V, VH, Sub V, Sub VB, J, Sub VCB
F. penneri	4	30	50/50 (Sa/Soil)	19	70%	14(54)	No Burrow	None
F. penneri	5	30	25/75 (Sa/Soil)	20	50%	14(14)	FB 5 A-G	V, Sub V, Sub VC, OB(2) (T1), OB (T2)
F. penneri	1	30	50/50 (Sa/Soil)	19	58%	14(19)	FB 4 A-B	V, H
F. penneri	1	30	25/75 (Sa/Soil)	20	52%	14(41)	No Burrow	None
N. americanus	5	30	25/75 (Sa/Soil)	20	51%	14(23)	OS 32	Sub V
N. americanus	1	30	25/75 (Sa/Soil)	20	60%	14(14)	OS 31 A-B	ODE (T2), O (T2)
N. americanus	1	65	100% Soil	39	60%	14(51)	OS 33 A-C	V, H

Experiment 3: Substrate Moisture

Species	Specimens	Tank Size	Sediment	Depth	% Moisture	Duration	Burrow #s	Burrow Architectures
F. penneri	5	65	50/50 (F/Soil)	45	49%	14(63)	FB 2 A-M	Sub V, V, J, JB
F. penneri	1	65	50/50 (F/Soil)	45	50%	14(13)	FB 3 A-I	Sub V, V
F. penneri	1	65	50/50 (F/Soil)	45	50%	14(14)	FB 1	HB
N. americanus	5	65	50/50 (F/Soil)	48	50%	14(22)	OS 29 A-C	V, O (T1), H
N. americanus	1	65	50/50 (F/Soil)	50	50%	14(21)	OS 30 A-F	V, VH, Sub V, Sub VC

	FP2C	FP3C	FP3D	FP3E	FP3F	FP3G	FP3H	FP3I	FP2E	FP2F	FP2G	FP6A	FP3A	FP5B	FP5C	FP5D	FP7A	FP7C	FP7E
PAST Identifier	FP1_SV	FP2_SV	FP3_SV	FP4_SV	FP5_SV	FP6_SV	FP7_SV	FP8_SV	FP9_SV	FP10_SV	FP11_SV	FP12_SV	FP13_SV	FP14_SV	FP15_SV	FP16_SV	FP17_SV	FP18_SV	✕
Architecture	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV
Surface Openings	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum Depth	3.5	1.7	3.3	3.3	3.6	6.8	6.5	8.2	7.9	6.9	4.4	1.8	1.5	2.8	4.2	5.7	2.1	4.1	8.7
Total Length	4.0	1.7	4.2	3.3	4.2	7.4	6.8	8.6	9.6	9.5	10.0	4.3	3.3	3.4	4.9	7.7	2.4	5.5	9.2
Maximum Width	1.3	0.9	1.4	1.4	1.4	1.1	1.3	1.3	1.3	1.2	0.7	1.7	0.8	1.6	1.3	1.6	1.1	1.6	1.5
Minimum Width	1.1	0.9	1.0	1.3	1.2	0.9	1.0	1.0	0.9	1.0	0.1	1.0	0.7	1.5	0.8	1.3	1.0	0.9	0.9
Average Width	1.2	0.9	1.1	1.4	1.3	1.0	1.1	1.1	1.1	1.1	0.4	1.4	0.8	1.5	1.1	1.4	1.1	1.3	1.2
Maximum Height	1.4	1.1	1.2	1.2	1.1	1.2	1.2	1.3	1.3	1.1	0.8	1.1	0.9	2.0	1.2	1.6	1.2	1.4	
Minimum Height	1.0	1.1	0.9	0.8	0.9	0.9	1.1	0.9	0.8	0.9	0.3	1.0	0.8	1.3	1.1	1.2	1.1	1.1	
Average Height	1.3	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.0	0.6	1.0	0.8	1.6	1.1	1.4	1.1	1.3	
Average W/H Ratio	1.0	0.9	1.1	1.4	1.3	1.0	1.0	1.1	1.0	1.1	0.7	1.3	1.0	1.0	1.0	1.0	0.9	0.9	1.2
Maximum Circumference	4.4	3.2	4	4.4	4	3.7	4	4.1	3.9	3.7	3.7	4.5	2.7	5.7	4.1	5.2	3.6	4.5	3.9
Minimum Circumference	3.4	3.2	3.1	3.7	3.8	2.9	3.1	3.2	3.2	2.9	2.4	2.8	2.6	4.6	3.2	3.3	3.1	3	2.9
Average Circumference	4.0	3.2	3.4	4.1	3.9	3.3	3.6	3.6	3.6	3.4	3.2	3.7	2.7	5.2	3.7	4.5	3.4	3.9	3.6
Maximum Slope	65	75	68	65	75	78	70	65	65	55	78	20	45	45	70	55	75	75	90
Minimum Slope	65	75	68	65	75	78	70	65	65	55	78	20	45	45	70	55	75	50	65
Average Slope	65	75	68	65	75	78	70	65	65	55	78	20	45	45	70	55	75	62	78
Branching Angle	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Complexity	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Tortuosity	1.0	1.0	1.2	1.0	1.2	1.1	1.0	1.1	1.1	1.2	1.1	1.4	1.6	1.1	1.1	1.2	1.1	1.3	1.1

	FP7F	FP7H	FP5E	FP3B	FP2A	FP2B	FP2D	FP4A	FP5A	FP7B	FP2M	FP7D	FP2I	FP2J	FP2K	FP2L	FP7G	FP2H	FP4B
PAST Identifier	FP19_SV	FP20_SVb	FP21_SVcb	FP22_SVc	FP23_VS	FP24_VS	FP25_VS	FP26_VS	FP27_VS	FP28_VS	FP29_VS	FP30_VS	FP31_VSh	FP32_JS	FP33_JS	FP34_JS	FP35_JS	FP36_JS	FP37_JSb
Architecture	SVb	SVcb	SVc	VS	VS	VS	VS	VS	VS	VS	VS	VSh	JS	JS	JS	JS	JS	JSB	HB
Surface Openings	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum Depth	8.0	7.4	5.2	2.2	4.1	3.1	6.0	3.3	2.1	3.6	3.6	6.9	6.5	7.8	8.1	2.9	8.4	5.8	3.1
Total Length	12.4	18.6	6.8	2.2	4.1	3.1	6.7	3.6	2.1	4.7	3.6	8.4	10.7	11.9	11.8	7.5	14.7	13.0	11.1
Maximum Width	1.8	3.0	1.6	1.3	1.1	1.5	1.6	1.7	1.7	1.5	2.3	1.4	1.2	1.7	1.2	1.1	1.3	1.3	1.4
Minimum Width	1.0	0.9	1.0	1.0	0.9	1.4	0.9	1.2	1.0	0.8	1.2	1.0	0.8	0.9	1.0	0.8	0.9	0.7	1.0
Average Width	1.4	1.7	1.3	1.1	1.0	1.4	1.3	1.5	1.4	1.2	1.7	1.2	1.0	1.2	1.1	0.9	1.1	1.1	1.2
Maximum Height	1.3	1.9	2.5	1.0	1.2	1.6	1.3	1.3	1.5	1.4	2.3	1.1	1.3	1.7	1.5	1.2	1.6	1.5	1.1
Minimum Height	1.0	0.9	1.2	0.9	1.0	1.4	1.0	1.1	1.2	1.2	1.3	1.0	0.9	0.9	1.0	0.7	1.0	0.8	0.8
Average Height	1.1	1.3	1.6	0.9	1.1	1.5	1.2	1.2	1.4	1.3	1.7	1.1	1.1	1.2	1.3	1.0	1.2	1.1	1.0
Average W/H Ratio	1.2	1.3	0.9	1.2	0.9	1.0	1.1	1.2	1.0	0.7	1.0	1.1	0.9	1.0	0.9	1.0	0.9	1.0	1.2
Maximum Circumference	4.5	8.1	6.2	3.6	3.8	5.2	5.6	5.5	4.6	4	6.5	3.8	3.7	5.3	4.2	3.5	4.2	6.4	4.3
Minimum Circumference	3.1	2.6	3.3	3	3.4	4.6	2.6	3.5	3.4	3.2	3.8	3.3	2.9	2.8	3	2.6	3.1	2.4	3.1
Average Circumference	4.0	5.0	4.7	3.3	3.6	4.9	4.4	4.6	4.0	3.6	5.2	3.6	3.2	3.8	3.8	3.1	3.9	3.7	3.6
Maximum Slope	90	90	65	90	85	90	85	90	90	90	90	90	80	90	55	55	75	65	70
Minimum Slope	50	20	45	90	85	90	60	90	90	40	90	55	15	50	50	45	75	25	0
Average Slope	70	50	55	90	85	90	73	90	90	65	90	73	47	70	53	50	75	45	35
Branching Angle	20	55	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	70	n/a
Complexity	3.0	4.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0
Tortuosity	1.1	1.5	1.3	1.0	1.0	1.0	1.1	1.1	1.0	1.2	1.0	1.2	2.2	2.0	2.0	5.8	2.4	1.4	4.3

	FP1	FP5F	FP6B	FP5G
PAST Identifier	FP38_HB	FP39_HBb	FP40_OS	FP41_OS
Architecture	HBb	Ob (T1)	Oc (T1)	Ob (T2)
Surface Openings	1	1	1	1
Maximum Depth	2.8	7.7	4.4	1.1
Total Length	11.1	17.5	13.0	10.1
Maximum Width	1.4	1.3	2.5	1.2
Minimum Width	0.8	0.9	1.0	0.9
Average Width	1.0	1.1	1.8	1.0
Maximum Height	0.7	1.4	1.6	1.1
Minimum Height	0.5	1.0	0.8	0.6
Average Height	0.6	1.2	1.2	0.8
Average W/H Ratio	1.6	0.9	1.5	1.3
Maximum Circumference	3.4	4.1	6.1	3.5
Minimum Circumference	2.2	3.2	2.6	2.7
Average Circumference	2.7	3.7	4.4	3.1
Maximum Slope	50	85	90	20
Minimum Slope	25	85	40	20
Average Slope	38	85	65	20
Branching Angle	10,45	12, 25	n/a	10
Complexity	6.0	6.0	4.0	4.0
Tortuosity	1.1	17.6	53.0	1.4

	NA32	NA23	NA25A	NA21A	NA21B	NA21C	NA30B	NA30D	NA21D	NA24	NA21E	NA26A	NA30E	NA28	NA29C	NA30A	NA30C	NA33A	NA33B
PAST Identifier	NA1_SS	NA2_SS	NA3_SS	NA4_SS	NA5_SS	NA6_SS	NA7_SS	NA8_SS	NA9_SS	NA10_SS	NA11_SS	NA12_SS	NA13_SS	NA14_VS	NA15_VS	NA16_VS	NA17_VS	NA18_VS	NA19_VS
Architecture	SS	SS	SS	SS	SS	SS	SS	SS	SSb	SSc	SSc	SSc	SSc	VS	VS	VS	VS	VS	VS
Surface Openings	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum Depth	4.1	6.7	3.0	1.9	4.0	7.1	2.6	5.9	11.9	4.0	13.4	5.8	6.6	2.4	1.9	2.5	2.3	3.1	2.2
Total Length	4.3	8.2	9.4	2.3	4.3	8.0	3.1	6.8	13.8	7.2	15.7	6.8	7.5	3.0	1.9	2.5	2.6	3.1	3.0
Maximum Width	0.93	1.69	1.17	1.30	1.45	1.15	0.96	1.08	1.17	1.76	1.68	2.62	1.65	1.40	1.17	0.93	1.04	1.20	1.38
Minimum Width	0.85	0.80	0.78	1.05	1.10	0.88	0.95	0.75	0.86	0.71	0.72	1.12	0.60	1.40	1.17	0.70	0.93	1.04	1.30
Average Width	0.88	1.04	1.02	1.18	1.24	0.93	0.96	0.93	1.02	1.09	1.05	1.56	1.14	1.40	1.17	0.82	0.99	1.12	1.34
Maximum Height	0.98	0.95	1.01	1.25	1.23	0.88	0.98	1.09	1.16	0.97	1.04	1.64	1.00	1.38	0.90	0.88	0.93	1.47	1.41
Minimum Height	0.86	0.73	0.57	1.18	1.05	0.74	0.82	0.81	0.63	0.60	0.58	0.89	0.70	0.95	0.90	0.77	0.80	1.11	1.06
Average Height	0.92	0.83	0.79	1.22	1.14	0.81	0.90	0.94	0.93	0.80	0.91	1.16	0.84	1.17	0.90	0.83	0.87	1.29	1.24
Average W/H Ratio	1.0	1.3	1.3	1.0	1.1	1.1	1.1	1.0	1.1	1.3	1.2	1.4	1.3	1.2	1.3	1.0	1.1	0.9	1.1
Maximum Circumference	3	4.1	3.7	4.2	4.3	3.1	2.9	3.5	3.6	4.6	4.3	8.4	4.7	5	3.5	2.8	3.1	4.3	4.4
Minimum Circumference	2.7	2.7	2.5	3.5	3.3	2.2	2.8	2.7	2.6	2.5	2.3	3.3	2.5	3.7	3.5	2.4	2.8	3.5	3.9
Average Circumference	2.8	3.1	3.1	3.9	3.7	2.7	2.9	3.1	3.1	3.3	3.2	4.9	3.5	4.4	3.5	2.6	3.0	3.9	4.2
Maximum Slope	70	65	45	33	73	90	70	80	90	67	81	55	90	85	80	90	80	90	90
Minimum Slope	70	50	25	33	70	25	70	60	40	20	55	55	65	85	80	90	80	90	90
Average Slope	70	38	35	33	72	57	70	70	63	44	64	55	78	85	80	90	80	90	90
Branching Angle	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	60	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Complexity	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0	3.0	4.0	3.0	4.0	2.0	2.0	2.0	2.0	2.0	2.0
Tortuosity	1.0	1.2	1.7	1.0	1.1	1.1	1.2	1.2	1.1	1.5	1.1	1.1	1.1	1.3	1.0	1.0	1.1	1.0	1.0

	NA30F	NA1	NA25B	NA33C	NA29B	NA21F	NA29A	NA26B	NA31A	NA31B
PAST Identifier	NA20_VS	NA21_HB	NA22_HB	NA23_HB	NA24_HB	NA25_HB	NA26_OS	NA27_OS	NA28_OS	NA29_OS
Architecture	VSh	HB	HB	HB	HBb	HBc	OS	O S	OS	OS
Surface Openings	1	1	1	1	1	1	1	1	2	1
Maximum Depth	5.9	2.8	2.5	3.0	3.4	2.9	3.4	6.9	2.5	1.9
Total Length	11.8	7.0	8.4	6.8	10.7	10.0	10.6	12.5	12.3	10.0
Maximum Width	1.04	1.02	1.10	1.18	1.06	1.65	1.29	1.80	1.34	1.09
Minimum Width	0.72	0.74	0.90	0.70	0.74	0.68	0.83	0.74	0.87	0.91
Average Width	0.91	0.89	1.01	0.96	0.84	1.16	1.05	1.09	1.04	1.01
Maximum Height	0.96	0.98	0.91	1.17	0.92	1.15	0.96	1.13	1.27	1.17
Minimum Height	0.67	0.63	0.58	0.85	0.61	0.80	0.60	0.67	0.93	0.89
Average Height	0.83	0.83	0.80	0.98	0.78	0.97	0.82	0.93	1.04	0.99
Average W/H Ratio	1.1	1.1	1.3	1.0	1.1	1.2	1.3	1.2	1.0	1.0
Maximum Circumference	3.2	3.2	3.3	4.3	3	4.3	3.5	4.8	3.9	3.6
Minimum Circumference	2.1	2.2	3	2.3	2.5	2.3	2.7	2.3	2.9	3.1
Average Circumference	2.8	2.8	3.2	3.1	2.7	3.4	3.1	3.4	3.5	3.3
Maximum Slope	90	60	50	80	60	55	60	60	90	20
Minimum Slope	0	15	0	50	60	0	15	60	0	20
Average Slope	45	45	25	65	75	25	38	60	43	20
Branching Angle	n/a	n/a	n/a	n/a	90	n/a	n/a	n/a	n/a	n/a
Complexity	2.0	2.0	2.0	2.0	4.0	4.0	3.0	3.0	6.0	2.0
Tortuosity	2.0	3.5	5.6	2.3	1.5	1.2	43.0	39.0	1.8	99.0