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APPENDIX E. COMBINED DATA SET FOR CASE STUDIES I AND II

E.1. EXAMPLE CALCULATION OF THE EXTIRPATION CONCENTRATION AFFECTING 95% OF TEST ORGANISMS (XC_{95}) VALUES FOR COMBINED DATA SET FROM CASE STUDY I AND II

Extirpation concentration affecting 95% of test organisms (XC_{95}) values have potential uses beyond the development of water quality criteria which have only recently been explored (Coffey et al., 2014; Cormier et al., 2012). Because some scientists may wish to explore a variety of possible applications, the XC_{95} values for the combined data sets from Case Study I and II are provided here.

XC_{95} values vary among ecoregions as seen in Appendix Sections A.3 and B.3. This variance has several potential sources due to biology, human error, and sampling.

The biological variance is primarily due to the differences in species occurrence and relative abundance in different ecoregions. If the species in a genus have diverged in their tolerance for dissolved minerals, differences in the degree to which species are represented in different regions can result in different XC_{95} values for that genus. For example, analyses of fish species within the same genus result in a range of XC_{95} values with the genus typically greater than the species XC_{95} values for that genus (see Appendix G).

Variance also results from human error in the identification of organisms. Identification of aquatic insects requires skill and knowledge and is subject to errors. If the individuals in different ecoregions are identified differently, that can be an important source of variance. More fundamentally, because gross morphology is used in insect taxonomy rather than genetics, the taxonomy of some genera may be phylogenetically incorrect, resulting in larger than expected variance within a genus.

Variance is also due to sampling variance found in all field ecological studies. Samples from different ecoregions include different ranges of exposure, different distributions of exposure across the exposure gradient, different seasonal distributions of samples, different levels of co-occurring variables, and different sample sizes. More fundamentally, different data sets taken from any distributed variable will exhibit random variance due to sampling.

Not surprisingly, for the most part, the XC_{95} values for the combined data sets are intermediate to the XC_{95} values calculated separately in Case Study I and II and the confidence intervals (CIs) overlap for the results from the data sets (see Figure E-1). Separately calculated

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XC_{95} values for a few genera (e.g., *Drunella*, *Pycnosyche*) do not overlap or have very different confidence intervals. The differences in individual genera cannot be explained by this data set but additional studies may provide explanations. However, it appears that the variance is random or species representation appropriate to the ecoregion and not due to a factor that significantly biases the XC_{95} values.

For developing ecoregional conductivity criteria using this field-based approach, the precision of each XC_{95} value is less critical than obtaining samples of genera that are representative of the geographic areas of interest. The variance between the ecoregions in Case Study I and II is not large relative to the variance seen in some laboratory toxicity tests within a genus. For example, *Daphnia* lethal concentration affecting 50% of test organisms for $CaCl_2$ range from 92 to 486 mg/L, a fivefold difference (U.S. EPA, 1988).

However, XC_{95} values have been used for other purposes that include representing how a genus in general responds to specific conductivity independent of its occurrence within an ecoregion, and so the reliability of the XC_{95} is more important than the loss of discriminatory power for species that may be regionally restricted (Coffey et al., 204; Cormier et al., 2012). Because of the usefulness of XC_{95} values for this alternative purpose, the U.S. Environmental Protection Agency (EPA) has calculated the XC_{95} values for the larger example (combined) criterion-data sets from Case Study I and II because the larger data set is more likely to be representative of the genus than a more geographically circumscribed data set and the larger data set expands the exposure range and nearly doubles the sample size. This results in XC_{95} values for 176 genera. However, more species within a genus are likely to be included in a broader geographic range and the resultant XC_{95} may represent the maximum effect level for the genus rather than the effect of the most salt-intolerant species in either ecoregion. See Appendix G for a comparison of species and genus level XC_{95} values.

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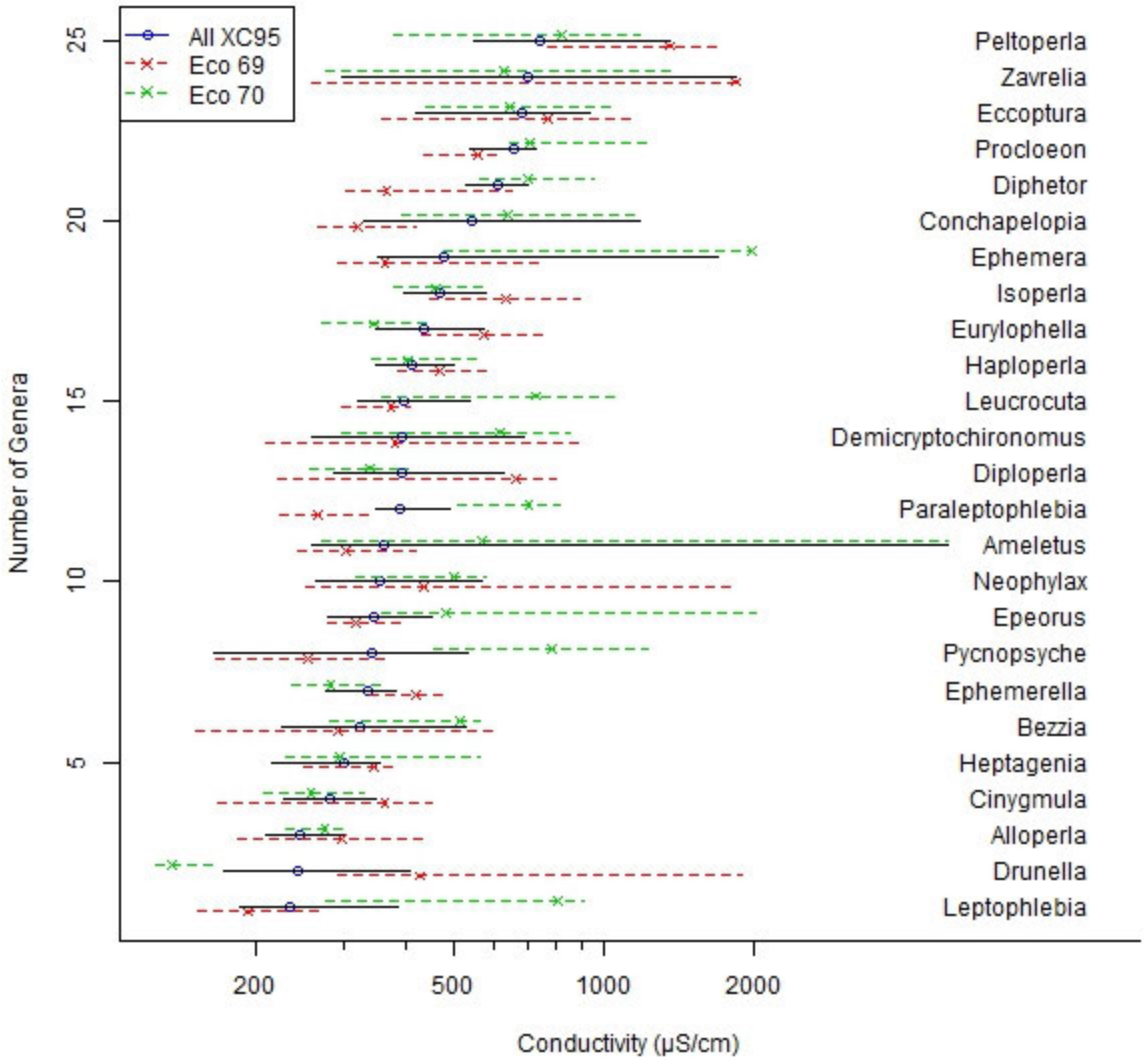

Figure E-1. The extirpation concentration (XC_{95}) values for the 25 most salt-intolerant genera that were calculated for Case Study I, Case Study II, and both combined. Genera occurring in only Case Study I, Case Study II, or the combined data set are not compared. Specific conductivity is represented on the *x*-axis and the rank order starting with the most salt-intolerant is represented on the y-axis. Three XC_{95} values and associated 95% confidence intervals are shown for each genus. XC_{95} (open circles) and 95% confidence intervals (CI) (solid line) are shown in black for the combined data sets of Case Study I and II. XC_{95} values for Case Study I are shown in red (lower *x* of triplet) and for Case Study II are shown in green (upper *x* of triplet) as well as their 95% CI (hashed lines).

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E.2. CASE STUDY I AND II COMBINED EXTIRPATION CONCENTRATION (XC_{95}) VALUES

Order	Family	Genus	Symbol	XC_{95}	95% CI	*N*
Plecoptera	Perlodidae	*Remenus*		108	86−259	63
Ephemeroptera	Ephemerellidae	*Timpanoga*		138	108−383	33
Plecoptera	Taeniopterygidae	*Strophopteryx*		159	115−392	29
Trichoptera	Lepidostomatidae	*Lepidostoma*	~	183	104−392	170
Plecoptera	Chloroperlidae	*Utaperla*		231	184−300	48
Ephemeroptera	Leptophlebiidae	*Leptophlebia*		235	185−387	115
Ephemeroptera	Ephemerellidae	*Drunella*		243	172−408	295
Plecoptera	Peltoperlidae	*Tallaperla*		243	156−589	121
Plecoptera	Chloroperlidae	*Alloperla*		245	210−301	131
Ephemeroptera	Heptageniidae	*Cinygmula*		281	227−348	224
Plecoptera	Perlodidae	*Clioperla*		299	117−1,590	27
Ephemeroptera	Heptageniidae	*Heptagenia*		301	215−356	113
Ephemeroptera	Heptageniidae	*Nixe*		316	273−394	219
Diptera	Ceratopogonidae	*Bezzia*		324	226−528	70
Plecoptera	Taeniopterygidae	*Taeniopteryx*		331	223−1,076	44
Diptera	Chironomidae	*Constempellina*		333	211−857	25
Ephemeroptera	Ephemerellidae	*Ephemerella*		335	277−381	683
Trichoptera	Limnephilidae	*Pycnopsyche*		343	164−534	93
Ephemeroptera	Heptageniidae	*Epeorus*		345	278−453	752
Trichoptera	Uenoidae	*Neophylax*		356	265−566	282
Ephemeroptera	Ameletidae	*Ameletus*		360	259−4,884	390
Diptera	Chironomidae	*Platysmittia*		387	127−702	35
Ephemeroptera	Leptophlebiidae	*Paraleptophlebia*		389	349−492	675
Plecoptera	Perlodidae	*Diploperla*		391	287−631	201
Diptera	Chironomidae	*Demicryptochironomus*		393	259−689	120
Ephemeroptera	Heptageniidae	*Leucrocuta*		396	320−536	369
Plecoptera	Nemouridae	*Prostoia*		401	272−508	35
Trichoptera	Glossosomatidae	*Agapetus*		404	210−487	41
Plecoptera	Perlodidae	*Yugus*		408	202−794	150
Plecoptera	Chloroperlidae	*Haploperla*		410	347−497	445
Plecoptera	Capniidae	*Paracapnia*		419	243−572	50
Ephemeroptera	Ephemerellidae	*Eurylophella*		434	348−574	289
Ephemeroptera	Ephemerellidae	*Serratella*		449	360−655	148
Trichoptera	Psychomyiidae	*Lype*		450	301−741	32

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Order	Family	Genus	Symbol	XC_{95}	95% CI	*N*
Coleoptera	Elmidae	*Promoresia*		456	320−931	128
Plecoptera	Perlodidae	*Isoperla*		468	396−578	868
Diptera	Tipulidae	*Brachypremna*		474	239−556	26
Ephemeroptera	Ephemeridae	*Ephemera*		478	350−1,693	220
Plecoptera	Pteronarcyidae	*Pteronarcys*	~	525	212−2,768	211
Diptera	Chironomidae	*Conchapelopia*		544	328−1,175	155
Diptera	Chironomidae	*Stempellina*		563	268−713	60
Ephemeroptera	Baetidae	*Diphetor*		611	528−705	249
Ephemeroptera	Baetidae	*Procloeon*		657	537−730	145
Plecoptera	Perlidae	*Eccoptura*	~	681	418−939	99
Diptera	Chironomidae	*Zavrelia*		704	297−1,837	93
Ephemeroptera	Baetidae	*Acerpenna*		710	453−1,036	63
Trichoptera	Goeridae	*Goera*	~	723	530−745	34
Plecoptera	Peltoperlidae	*Peltoperla*	>	746	547−1,349	188
Plecoptera	Perlodidae	*Cultus*		771	276−1,398	33
Plecoptera	Perlodidae	*Malirekus*	~	771	261−913	45
Ephemeroptera	Heptageniidae	*Maccaffertium*		779	680−851	793
Plecoptera	Nemouridae	*Amphinemura*		798	520−3,725	1,054
Coleoptera	Dytiscidae	*Hydroporus*		822	346−822	37
Ephemeroptera	Baetidae	*Plauditus*		843	723−1,176	716
Ephemeroptera	Heptageniidae	*Stenacron*	~	843	629−996	479
Diptera	Dixidae	*Dixa*	>	844	434−1,831	95
Ephemeroptera	Heptageniidae	*Stenonema*		845	712−937	1,218
Ephemeroptera	Baetiscidae	*Baetisca*		851	555−1,016	70
Trichoptera	Philopotamidae	*Wormaldia*	~	861	508−1,979	117
Trichoptera	Psychomyiidae	*Psychomyia*	>	895	608−1,388	58
Diptera	Chironomidae	*Krenosmittia*	~	913	235−1,540	32
Diptera	Chironomidae	*Stempellinella*	>	920	675−2,768	424
Ephemeroptera	Baetidae	*Acentrella*		947	712−2,087	1,291
Isopoda	Asellidae	*Asellus*		960	342−1,014	33
Trichoptera	Philopotamidae	*Dolophilodes*	>	1,036	599−7,053	564
Ephemeroptera	Baetidae	*Centroptilum*		1,101	600−1,175	104
Ephemeroptera	Isonychiidae	*Isonychia*		1,146	1,017−1,303	1,303
Diptera	Chironomidae	*Parachaetocladius*	>	1,183	600−2,768	232
Isopoda	Asellidae	*Lirceus*		1,190	784−1,347	153
Diptera	Chironomidae	*Diplocladius*		1,249	241−1,340	26

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Order	Family	Genus	Symbol	XC_{95}	95% CI	*N*
Decapoda	Cambaridae	*Cambarus*	>	1,311	1,028−1,994	658
Diptera	Chironomidae	*Rheopelopia*	>	1,341	435−2,523	134
Trichoptera	Polycentropodidae	*Neureclipsis*	>	1,424	711−1,620	32
Trichoptera	Glossosomatidae	*Glossosoma*	>	1,426	845−2,257	226
Veneroida	Pisidiidae	*Pisidium*	>	1,445	1,289−1,795	69
Diptera	Simuliidae	*Prosimulium*	~	1,451	478−2,439	271
Ephemeroptera	Baetidae	*Baetis*	>	1,460	1,171−1,859	2,493
Plecoptera	Capniidae	*Allocapnia*	~	1,478	230−1,540	34
Coleoptera	Psephenidae	*Ectopria*	>	1,505	1,016−2,768	501
Trichoptera	Rhyacophilidae	*Rhyacophila*	>	1,569	679−3,794	710
Diptera	Chironomidae	*Paracladopelma*	>	1,613	1,371−1,613	32
Diptera	Chironomidae	*Psilometriocnemus*	>	1,632	1,373−1,665	27
Diptera	Chironomidae	*Potthastia*	>	1,633	1,068−1,896	89
Diptera	Chironomidae	*Brillia*	>	1,676	1,065−2,768	152
Diptera	Chironomidae	*Parakiefferiella*	>	1,689	1,445−1,896	91
Diptera	Chironomidae	*Pagastia*	>	1,800	1,403−1,970	74
Diptera	Tipulidae	*Limnophila*	~	1,814	274−2,768	70
Diptera	Chironomidae	*Eukiefferiella*	>	1,858	1,585−2,020	796
Diptera	Tipulidae	*Ormosia*	>	1,959	1,263−1,977	42
Diptera	Chironomidae	*Heleniella*	>	2,016	916−2,768	74
Hemiptera	Veliidae	*Rhagovelia*	>	2,030	991−2,030	52
Odonata	Gomphidae	*Lanthus*	>	2,087	922−2,087	74
Plecoptera	Leuctridae	*Leuctra*	>	2,087	1,374−2,791	1,936
Plecoptera	Perlidae	*Paragnetina*		2,087	245−2,087	77
Diptera	Chironomidae	*Sublettea*	>	2,087	1,642−2,440	308
Coleoptera	Elmidae	*Macronychus*	>	2,160	1,489−2,160	99
Amphipoda	Crangonyctidae	*Crangonyx*	>	2,169	952−2,169	154
Diptera	Tipulidae	*Molophilus*	~	2,169	333−2,169	31
Diptera	Ceratopogonidae	*Atrichopogon*	>	2,257	1,120−2,257	60
Diptera	Chironomidae	*Chaetocladius*	>	2,320	1,700−5,057	270
Diptera	Chironomidae	*Krenopelopia*	>	2,320	1,700−2,320	63
Diptera	Chironomidae	*Phaenopsectra*	>	2,332	1,543−2,332	116
Odonata	Cordulegastridae	*Cordulegaster*	>	2,344	840−2,344	52
Diptera	Chironomidae	*Natarsia*	>	2,344	1,678−2,344	61
Diptera	Chironomidae	*Nilotanypus*	>	2,360	1,484−2,630	149
Trichoptera	Polycentropodidae	*Polycentropus*	>	2,445	1,381−4,713	641

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Order	Family	Genus	Symbol	XC_{95}	95% CI	*N*
Diptera	Chironomidae	*Cardiocladius*	>	2,485	1,573−3,174	374
Hemiptera	Veliidae	*Microvelia*	>	2,523	977−2,523	47
Diptera	Culicidae	*Anopheles*	>	2,768	823−2,768	28
Diptera	Chironomidae	*Zavrelimyia*	>	2,768	1,647−4,884	319
Trichoptera	Hydroptilidae	*Ochrotrichia*	>	2,791	1,210−2,791	54
Coleoptera	Elmidae	*Oulimnius*	>	2,791	1,327−5,000	409
Diptera	Chironomidae	*Tvetenia*	>	2,791	1,978−3,174	1,176
Diptera	Tipulidae	*Tipula*	>	3,140	2,020−6,492	967
Decapoda	Cambaridae	*Orconectes*	>	3,162	1,609−3,162	290
Diptera	Empididae	*Chelifera*	>	3,341	1,831−3,341	199
Diptera	Ceratopogonidae	*Dasyhelea*	>	3,341	1,608−3,341	109
Trichoptera	Hydropsychidae	*Diplectrona*	>	3,341	1,964−6,492	966
Coleoptera	Elmidae	*Microcylloepus*	>	3,341	1,796−3,341	231
Diptera	Chironomidae	*Orthocladius*	>	3,341	1,037−3,794	341
Diptera	Chironomidae	*Microtendipes*	>	3,489	1,694−7,053	823
Diptera	Chironomidae	*Paratanytarsus*	>	3,489	3,162−5,258	180
Ephemeroptera	Caenidae	*Caenis*	>	3,972	2,641−4,052	985
Diptera	Chironomidae	*Polypedilum*	>	4,400	3,162−7,093	2,749
Diptera	Chironomidae	*Rheotanytarsus*	>	4,400	2,573−4,636	1,558
Diptera	Chironomidae	*Corynoneura*	>	4,636	1,481−4,636	211
Diptera	Chironomidae	*Diamesa*	>	4,636	2,160−4,713	766
Diptera	Chironomidae	*Parametriocnemus*	>	4,636	2,572−4,969	2,277
Diptera	Chironomidae	*Rheocricotopus*	>	4,636	2,485−4,884	908
Isopoda	Asellidae	*Caecidotea*	>	4,713	1,970−4,713	246
Diptera	Empididae	*Clinocera*	>	4,713	1,418−4,713	83
Diptera	Tipulidae	*Antocha*	>	4,953	3,748−6,468	924
Diptera	Tipulidae	*Limonia*	>	5,057	2,160−5,057	68
Diptera	Chironomidae	*Limnophyes*	>	5,120	1,597−5,120	124
Diptera	Simuliidae	*Simulium*	>	5,120	2,874−7,053	1,965
Diptera	Chironomidae	*Cryptochironomus*	>	5,258	2,641−7,093	432
Diptera	Chironomidae	*Larsia*	>	5,258	1,408−5,258	121
Diptera	Chironomidae	*Tribelos*	>	5,258	1,309−5,258	79
Megaloptera	Corydalidae	*Nigronia*	>	5,720	3,162−9,790	1,172
Trichoptera	Hydropsychidae	*Ceratopsyche*	>	6,468	4,052−7,010	1,598
Diptera	Chironomidae	*Micropsectra*	>	6,468	1,870−6,468	390
Diptera	Chironomidae	*Paraphaenocladius*	>	6,468	1,461−6,468	77

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Order	Family	Genus	Symbol	XC_{95}	95% CI	*N*
Odonata	Gomphidae	*Stylogomphus*	>	6,468	2,344−6,468	161
Plecoptera	Perlidae	*Acroneuria*	>	6,492	1,793−11,646	802
Trichoptera	Philopotamidae	*Chimarra*	>	6,492	3,174−7,053	1,040
Plecoptera	Perlidae	*Perlesta*	>	6,492	1,468−6,492	518
Coleoptera	Psephenidae	*Psephenus*	>	6,492	5,068−9,790	1,503
Diptera	Tipulidae	*Pseudolimnophila*	>	6,492	1,331−6,492	221
Plecoptera	Chloroperlidae	*Sweltsa*	>	6,492	709−6,492	480
Diptera	Chironomidae	*Thienemannimyia*	>	6,492	4,400−7,053	2,326
Diptera	Tipulidae	*Dicranota*	>	7,010	1,914−7,370	529
Coleoptera	Elmidae	*Optioservus*	>	7,010	4,636−9,790	2,365
Coleoptera	Elmidae	*Stenelmis*	>	7,010	4,052−9,790	2,224
Odonata	Aeshnidae	*Boyeria*	>	7,340	2,445−7,340	272
Coleoptera	Elmidae	*Dubiraphia*	>	7,340	3,162−7,370	272
Diptera	Tipulidae	*Hexatoma*	>	7,340	4,884−9,790	1,251
Trichoptera	Hydropsychidae	*Hydropsyche*	>	7,370	4,713−10,140	1,628
Trichoptera	Hydropsychidae	*Cheumatopsyche*	>	9,180	5,258−9,180	2,816
Diptera	Chironomidae	*Tanytarsus*	>	9,180	4,884−9,790	1,920
Basommatophora	Physidae	*Physella*	>	9,790	6,468−9,790	231
Diptera	Tabanidae	*Tabanus*	>	9,790	2,291−9,790	83
Diptera	Chironomidae	*Thienemanniella*	>	9,790	6,468−11,227	580
Diptera	Empididae	*Hemerodromia*	>	10,235	7,010−11,646	865
Amphipoda	Gammaridae	*Gammarus*	>	10,350	2,316−10,350	317
Megaloptera	Corydalidae	*Corydalus*	>	11,227	7,010−11,646	599
Diptera	Chironomidae	*Cricotopus*	>	11,227	6,468−11,646	761
Trichoptera	Hydroptilidae	*Hydroptila*	>	11,227	5,319−11,646	615
Diptera	Chironomidae	*Procladius*	>	11,227	2,630−11,227	46
Megaloptera	Sialidae	*Sialis*	>	11,227	3,725−11,227	365
Diptera	Chironomidae	*Dicrotendipes*	>	11,310	9,790−11,646	377
Diptera	Chironomidae	*Ablabesmyia*	>	11,646	7,679−11,646	253
Diptera	Athericidae	*Atherix*	>	11,646	7,340−11,646	278
Diptera	Tabanidae	*Chrysops*	>	11,646	7,053−11,646	92
Diptera	Chironomidae	*Cladotanytarsus*	>	11,646	5,266−11,646	178
Coleoptera	Dryopidae	*Helichus*	>	11,646	1,528−11,646	553
Diptera	Chironomidae	*Pseudochironomus*	>	11,646	4,400−11,646	74

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E.3. CASE STUDY I AND II COMBINED GENERALIZED ADDITIVE MODEL (GAM) PLOTS

The generalized additive model (GAM) plots used to designate ~ and > values for those XC_{95} values are depicted in this Appendix (see Section E.3). In this example, the probability of observing a genus is the proportion of sampled stations in a conductivity bin with the genus present based on taxonomic identification of 200 individuals per sample. Conductivity is reported as specific conductivity. The red, dashed vertical line is the XC_{95} value for the genus (see Section E.2) obtained from the plots of the cumulative distribution function's (CDFs) in Appendix Section E.4. Plots are arranged from the lowest to the highest XC_{95} value.

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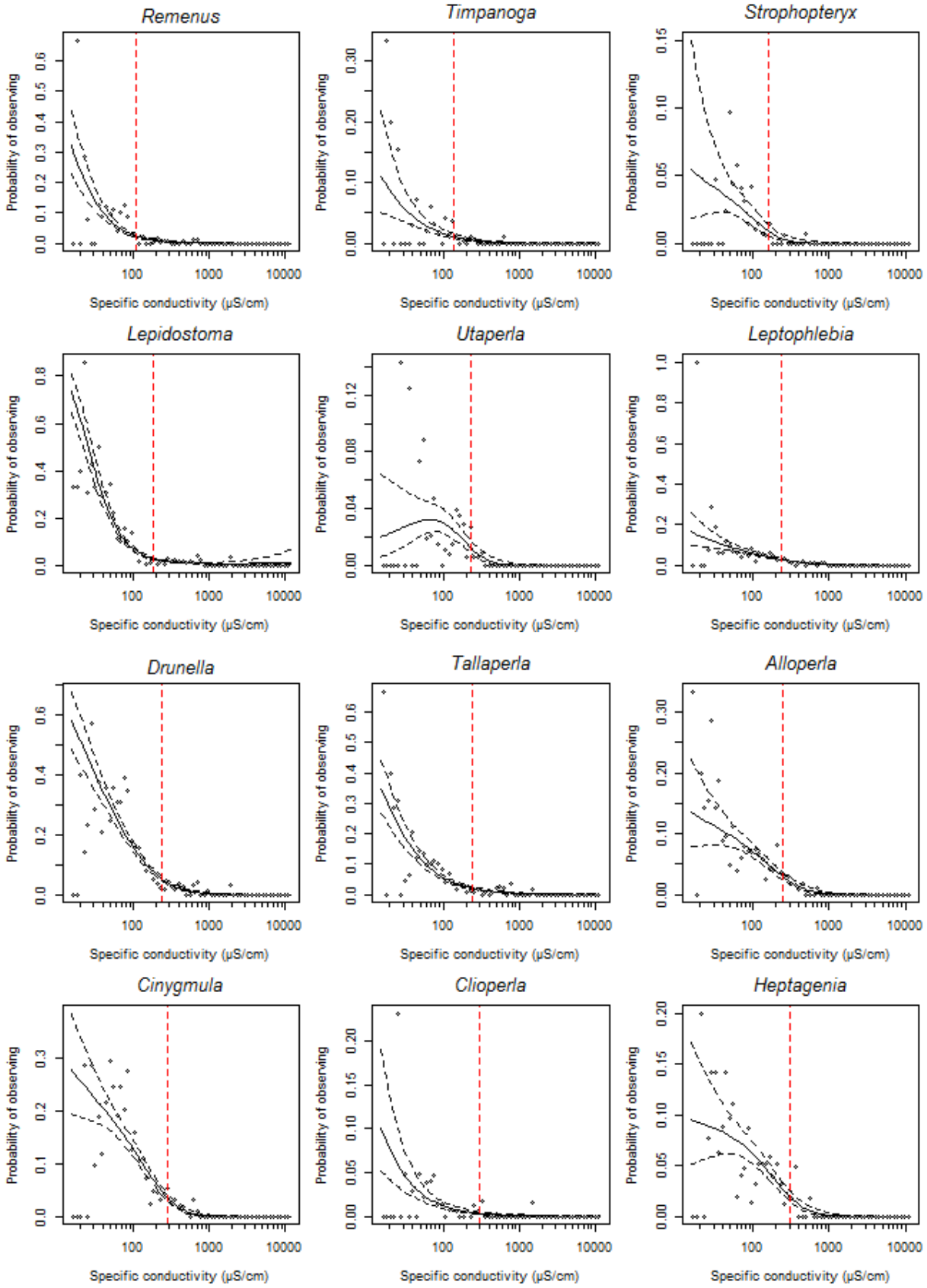

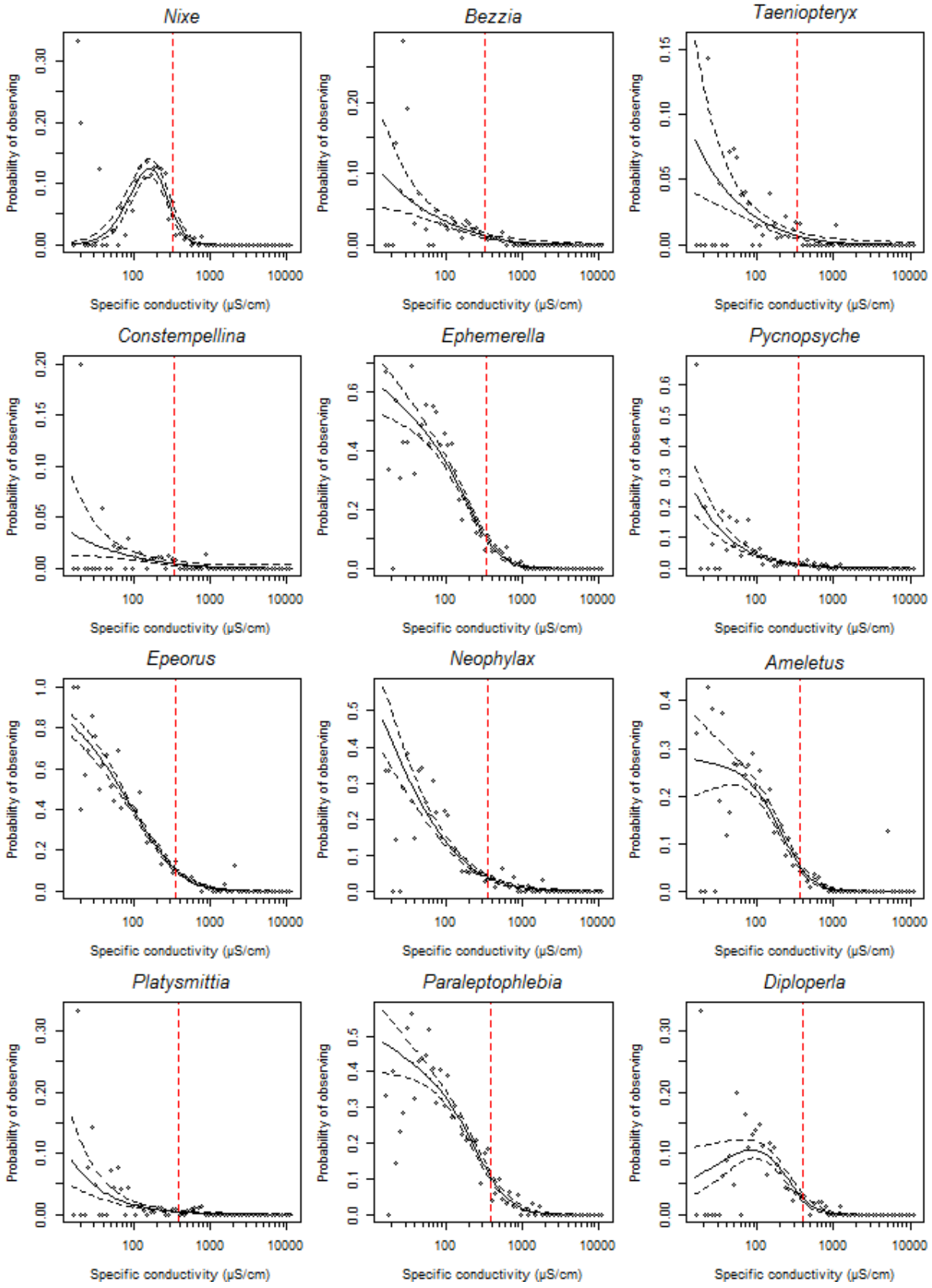

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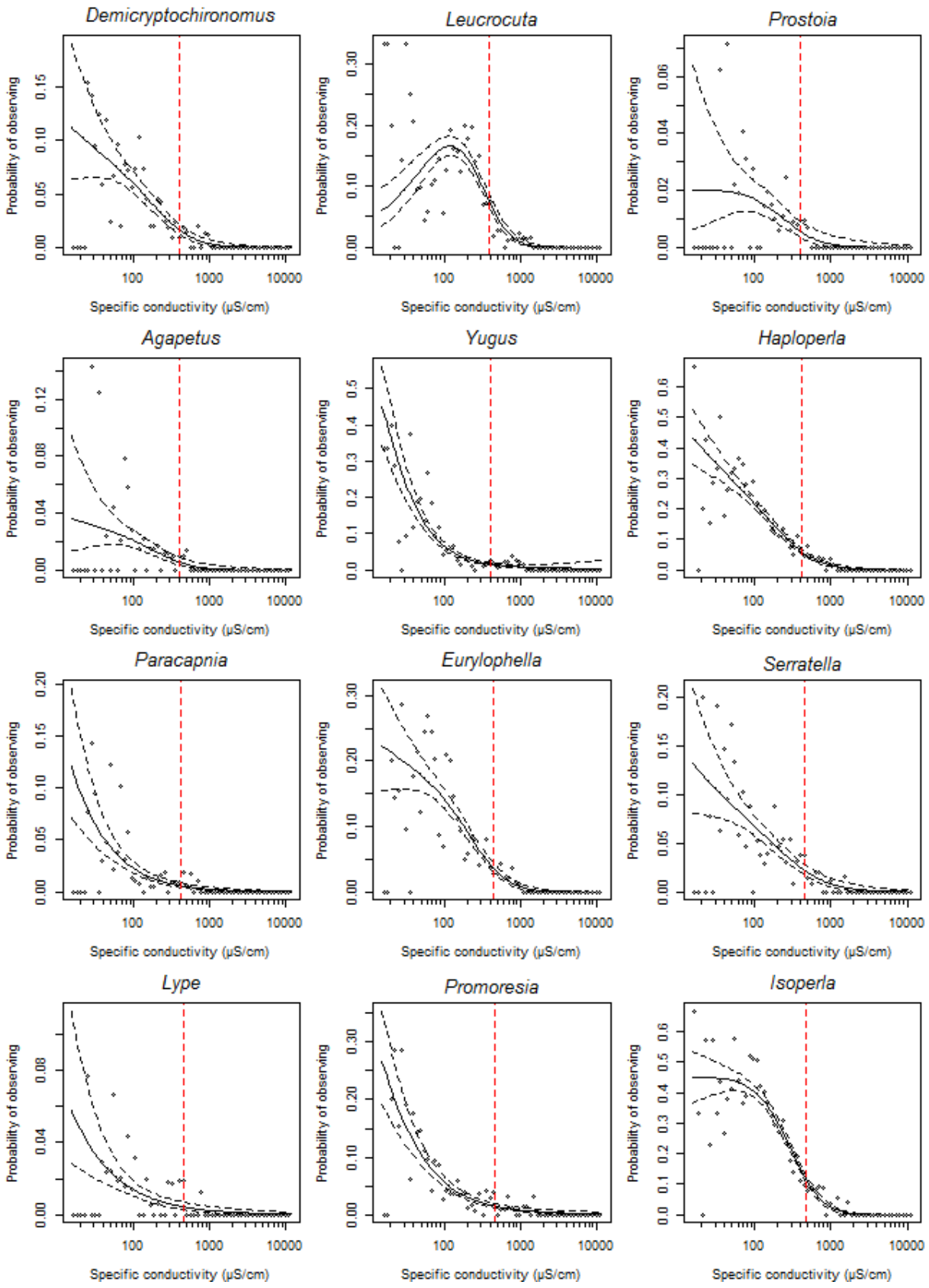

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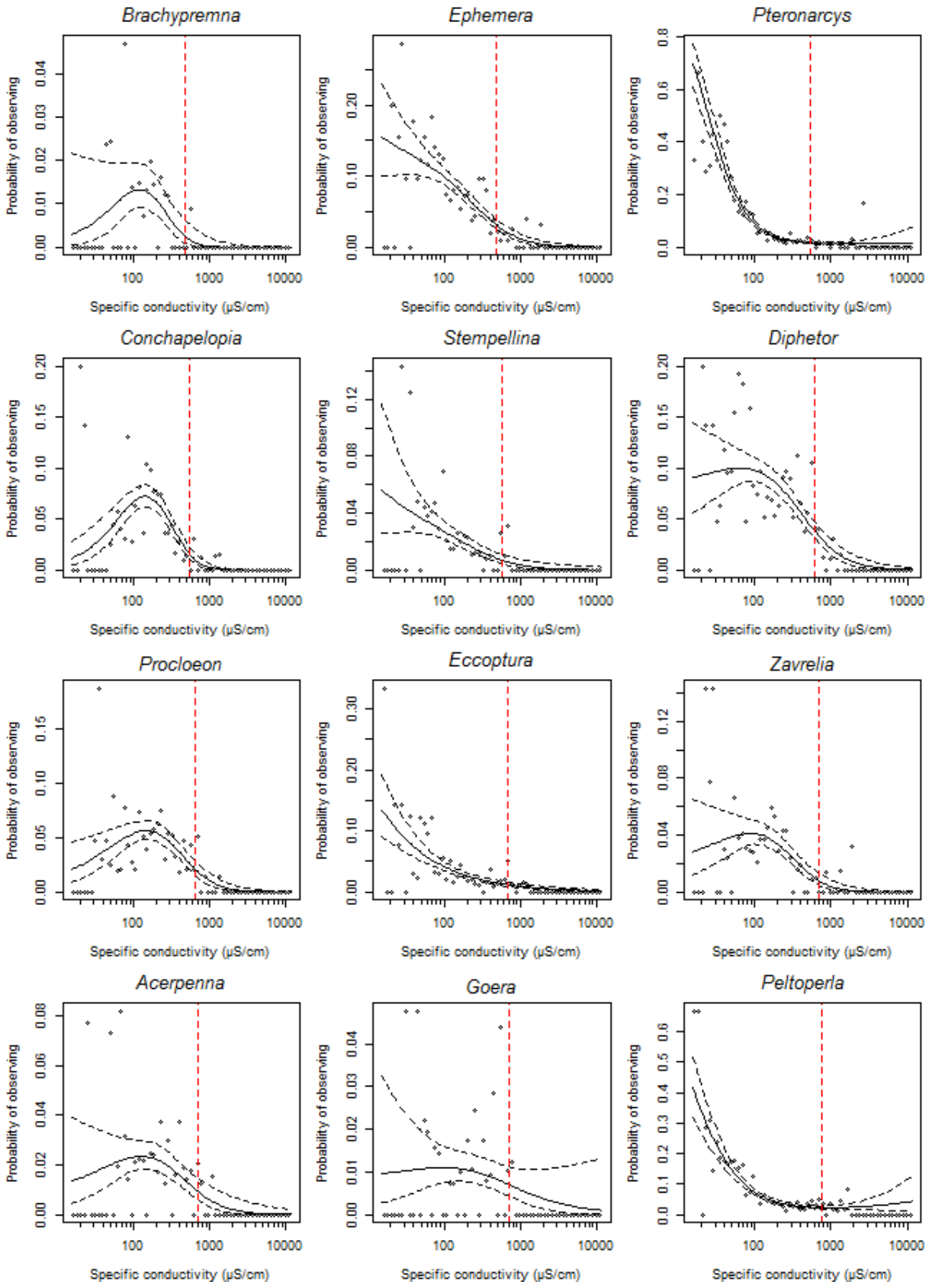

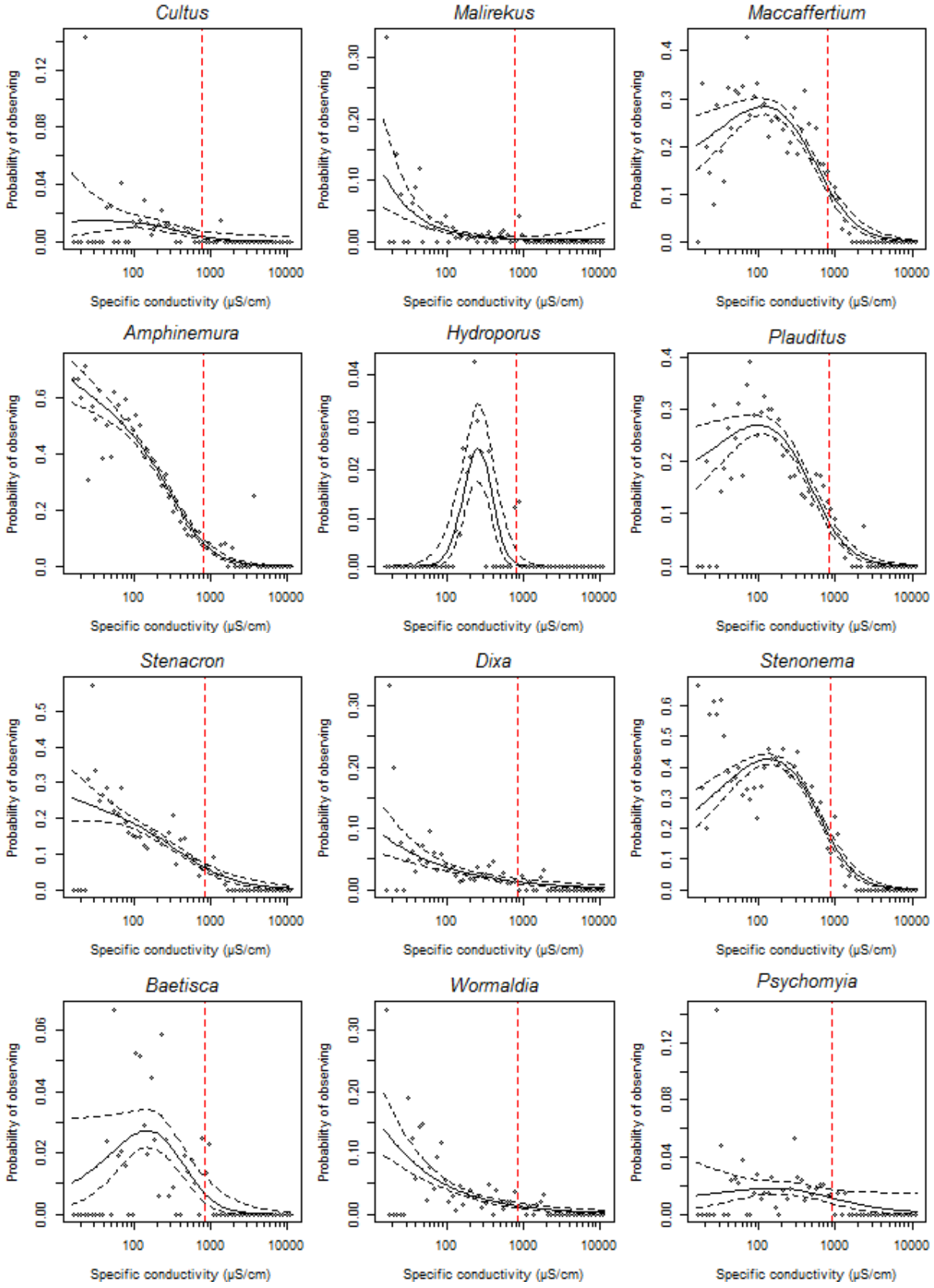

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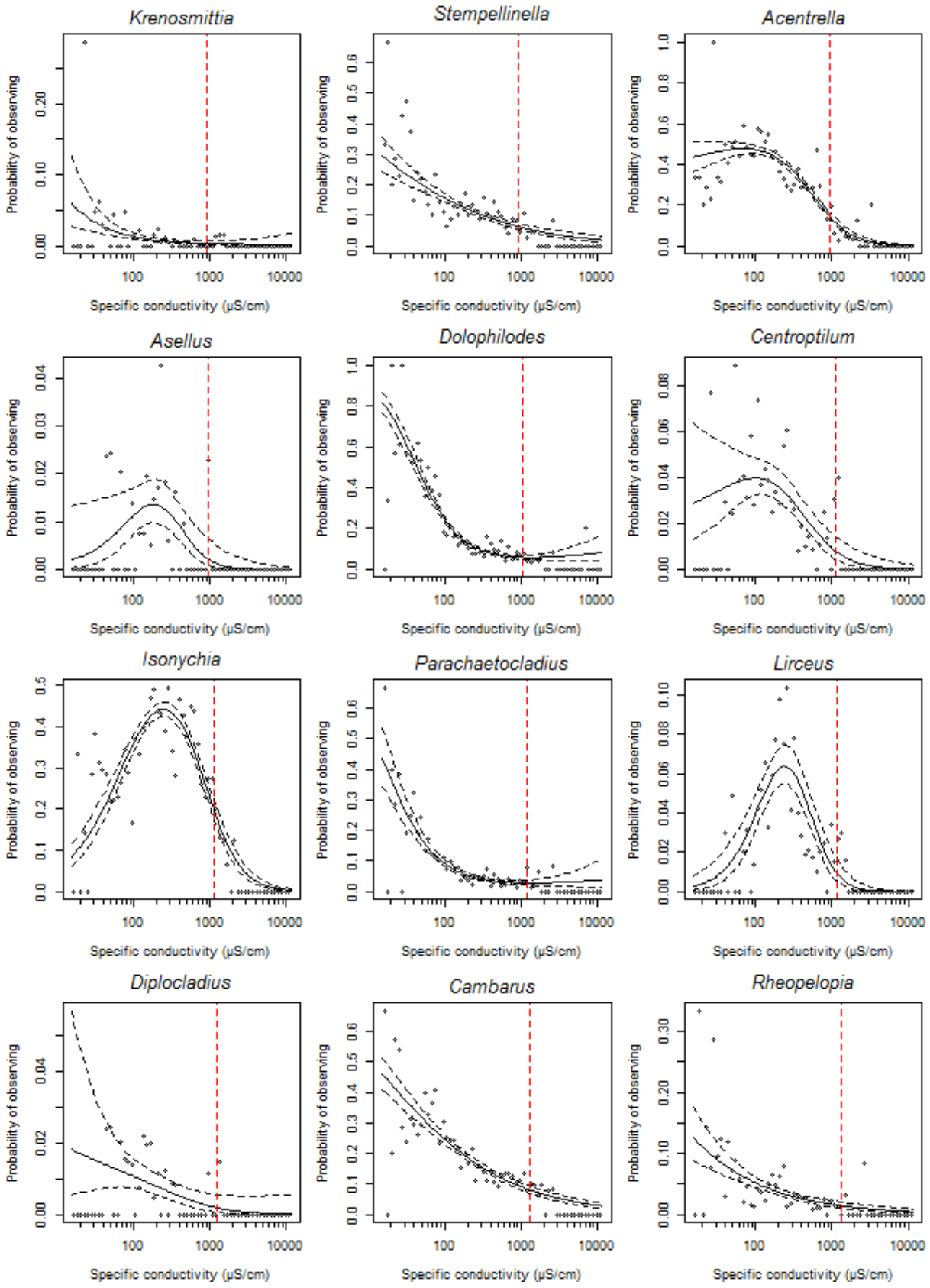

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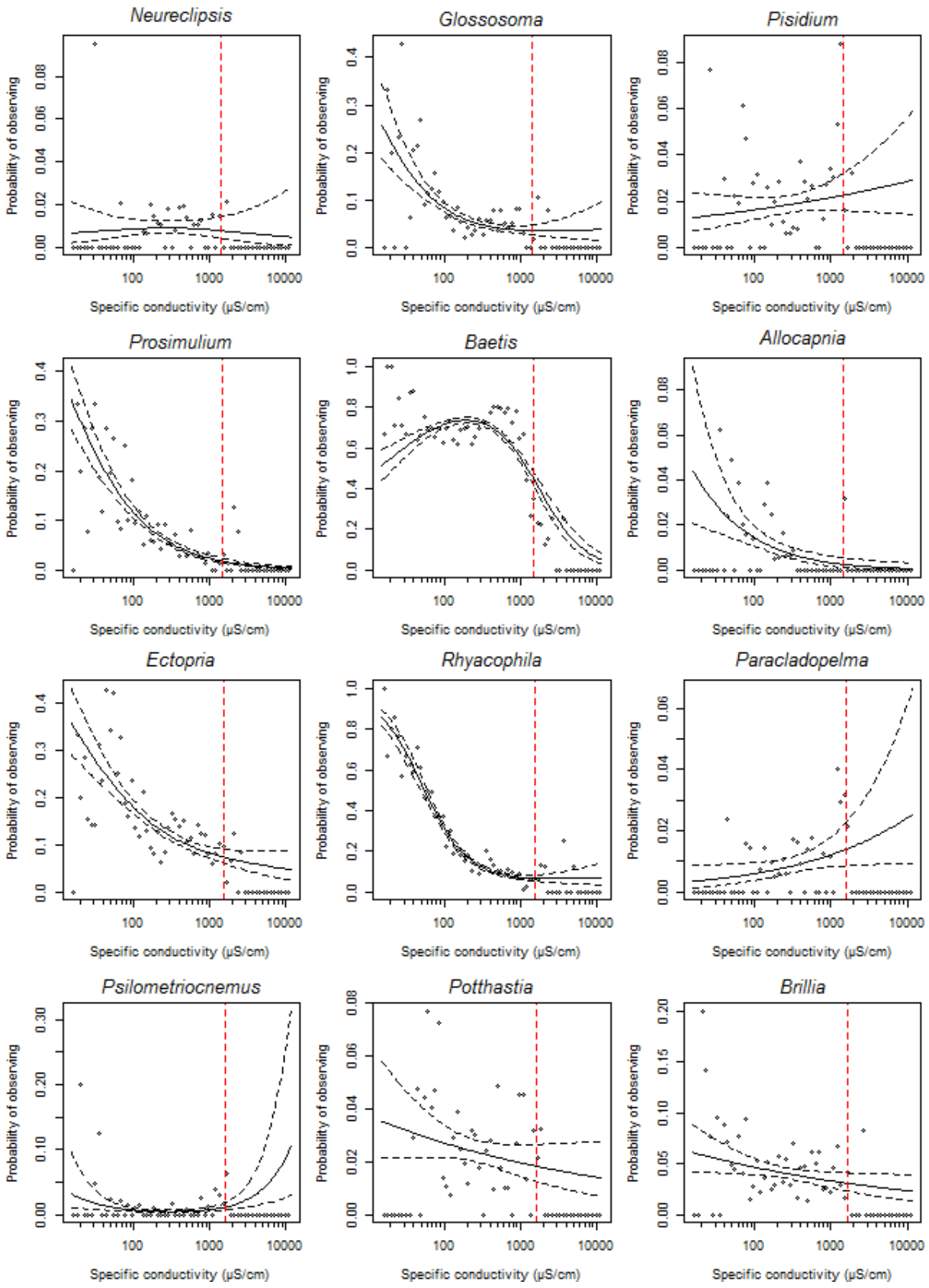

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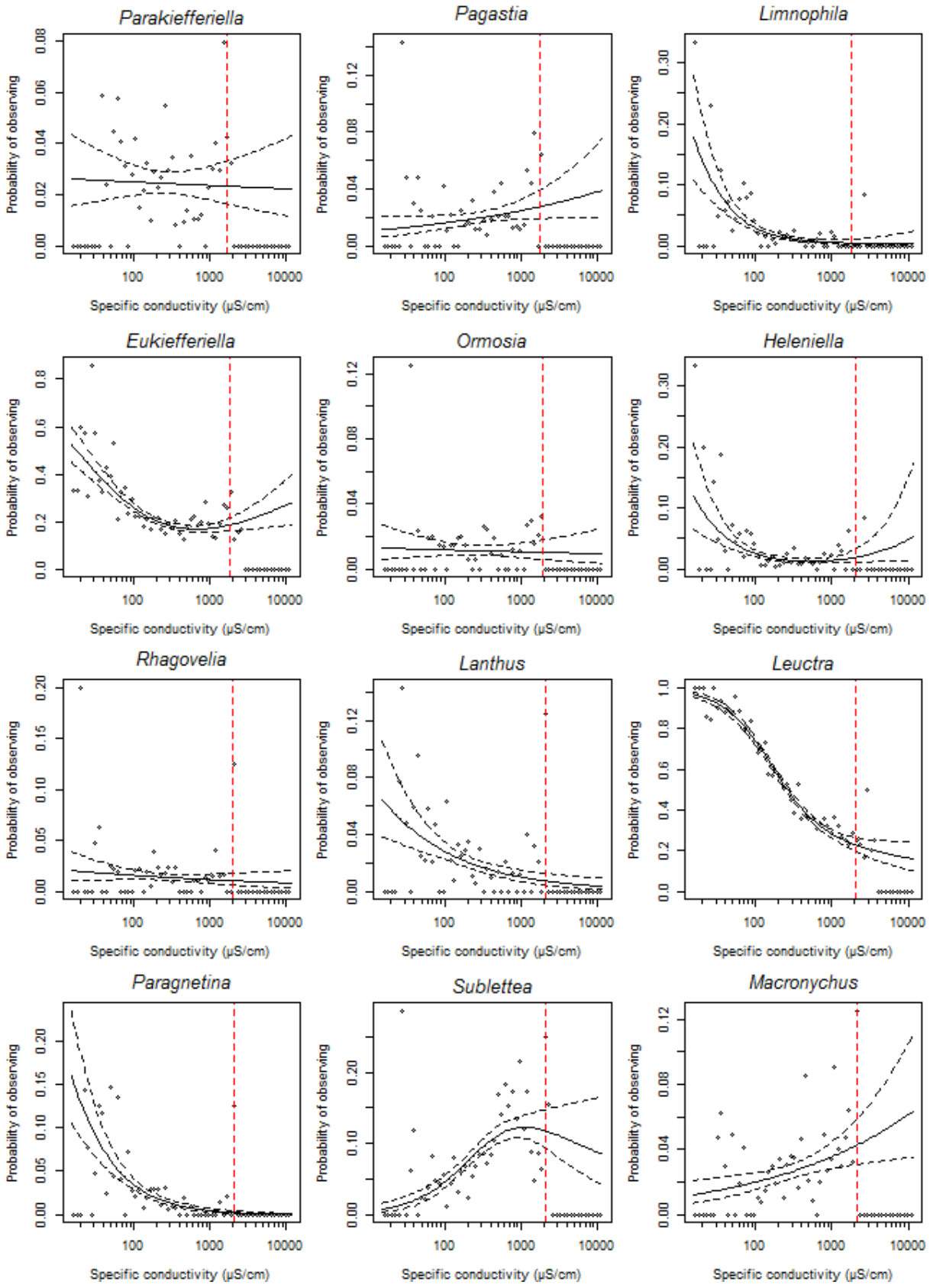

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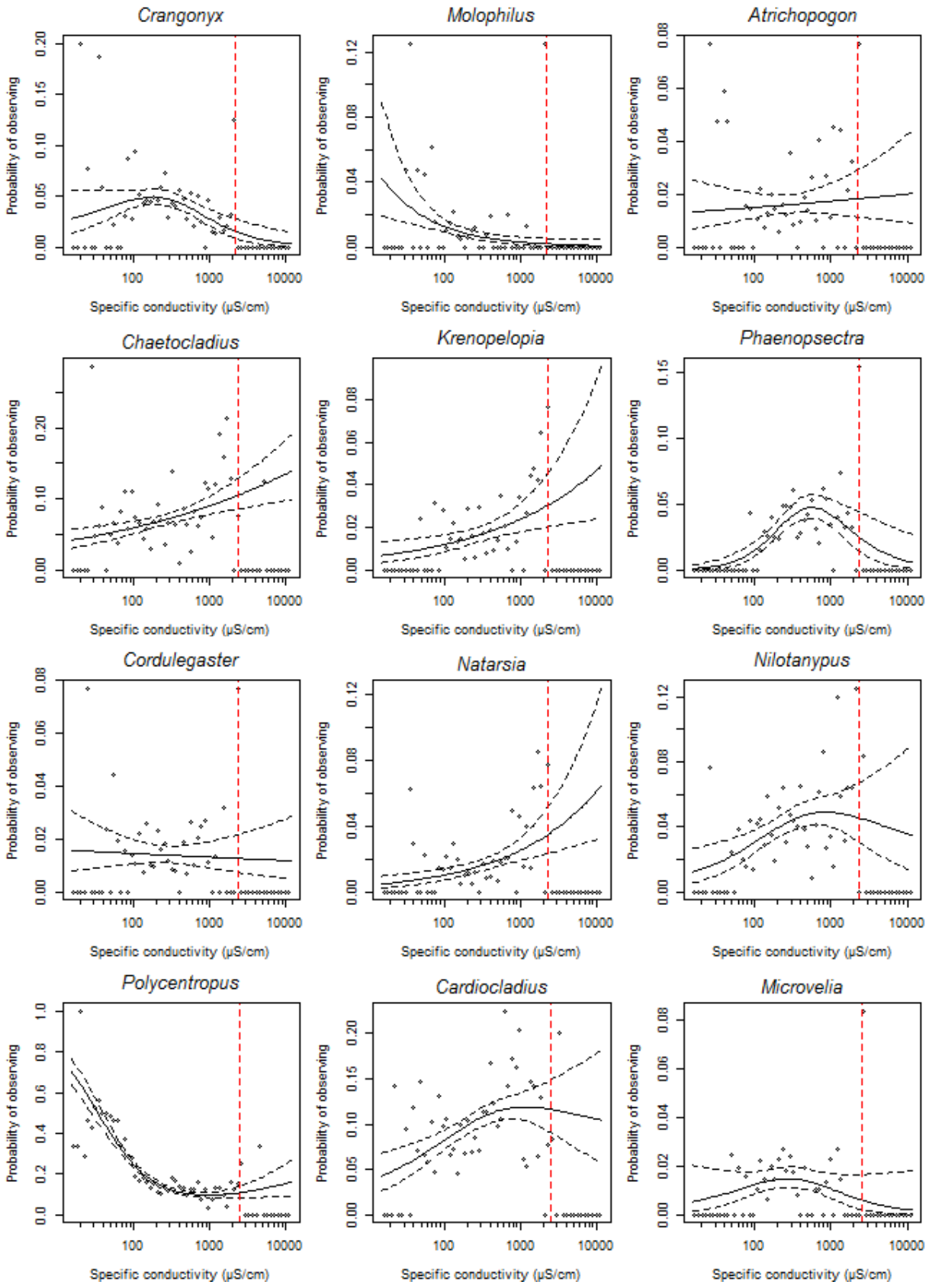

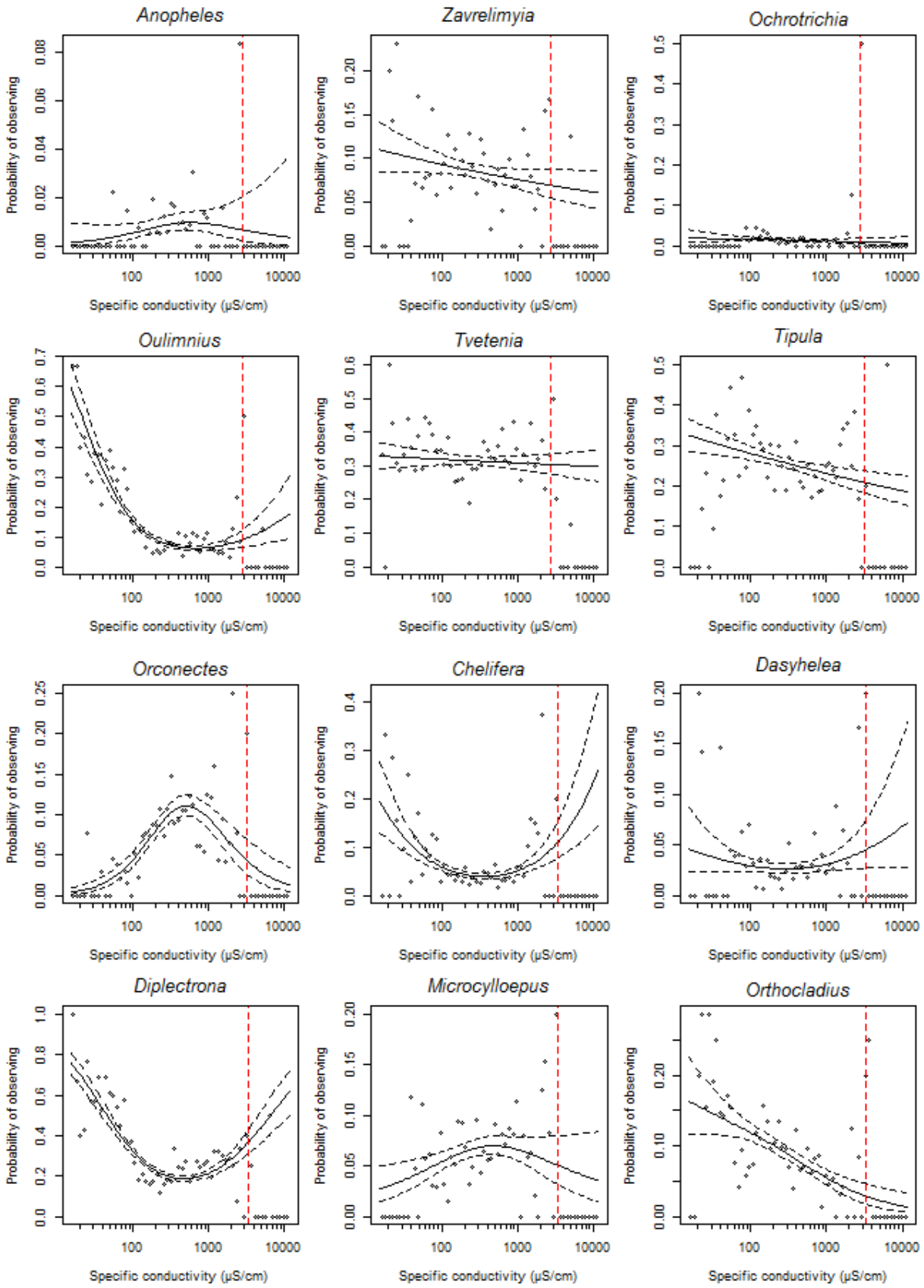

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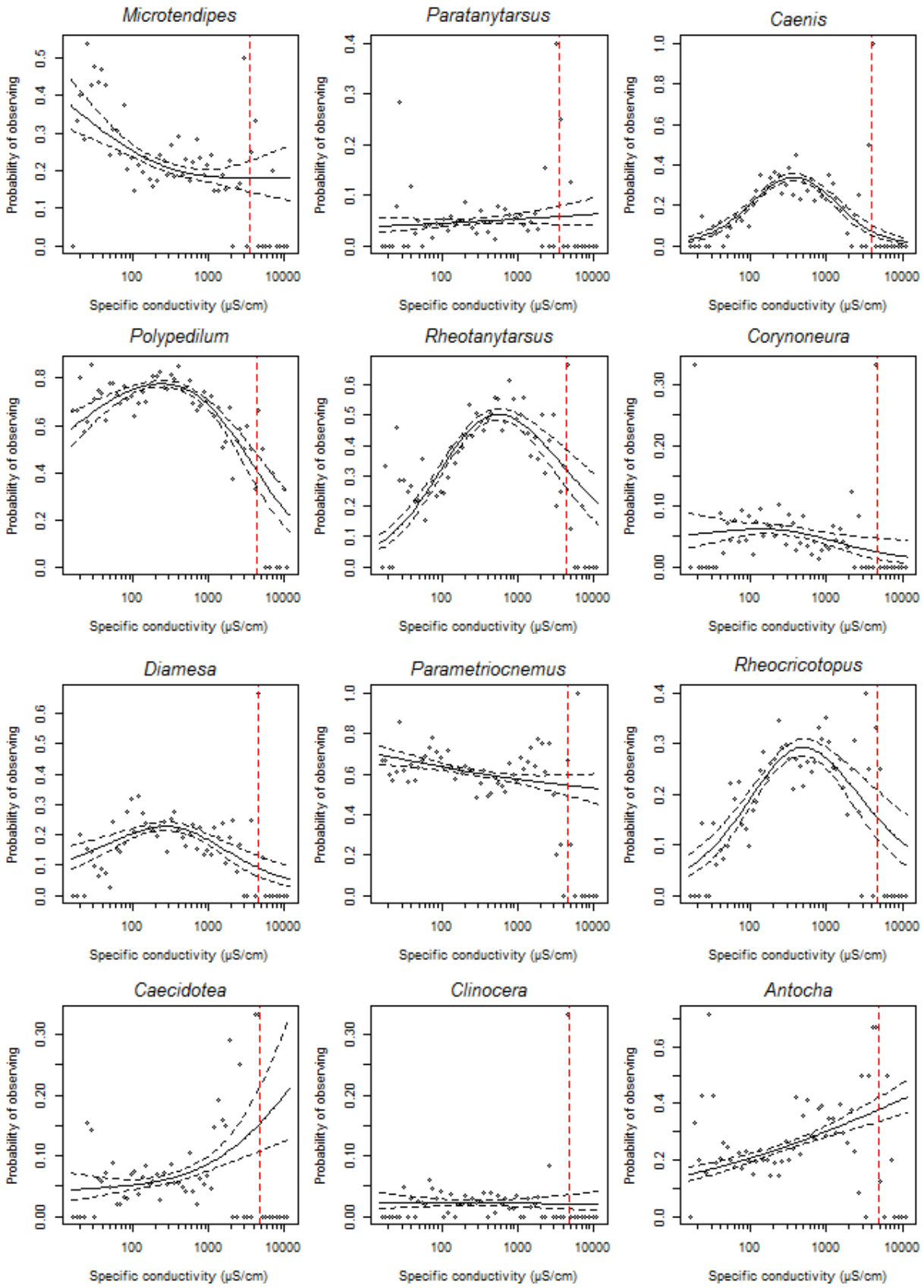

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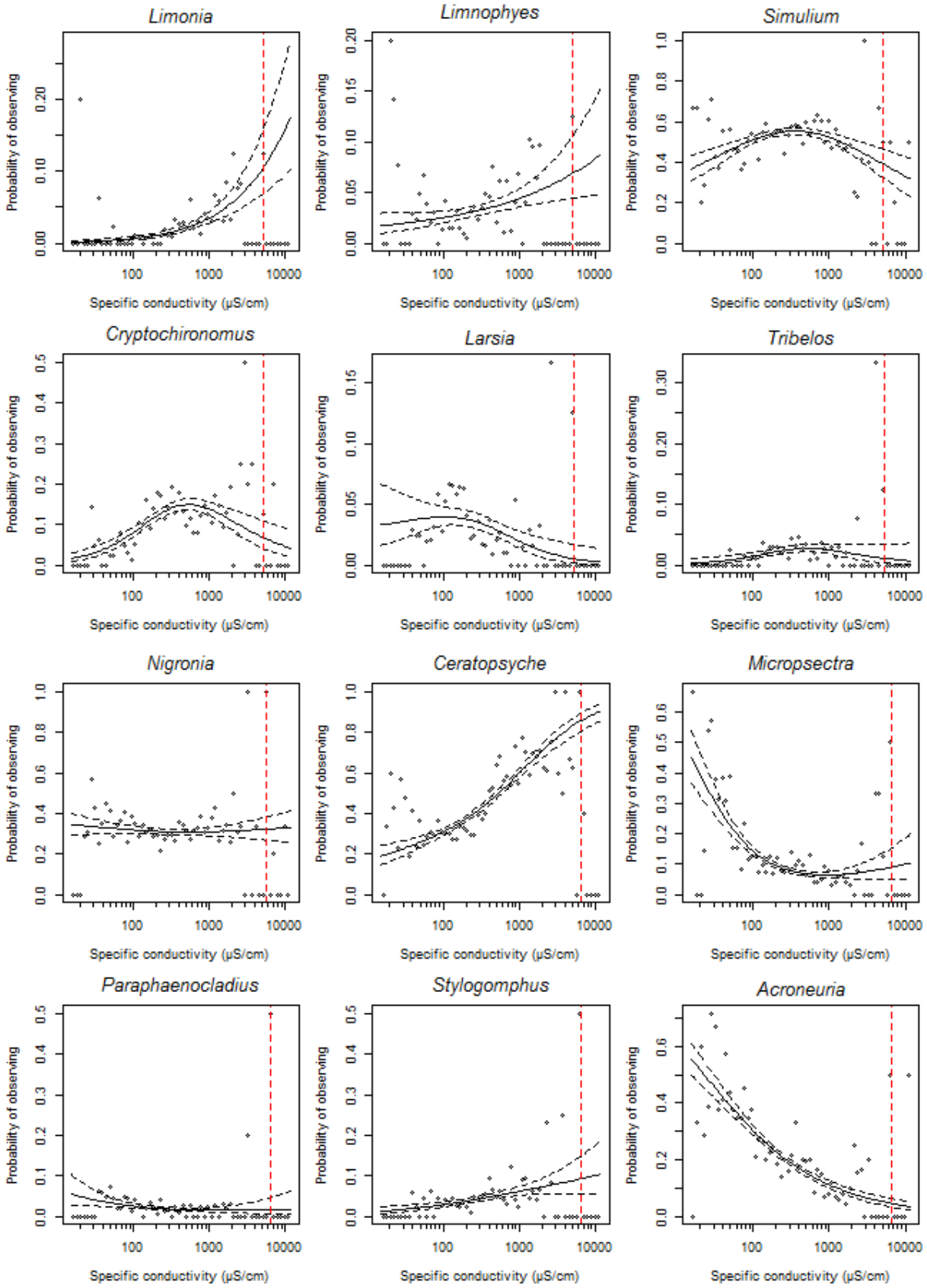

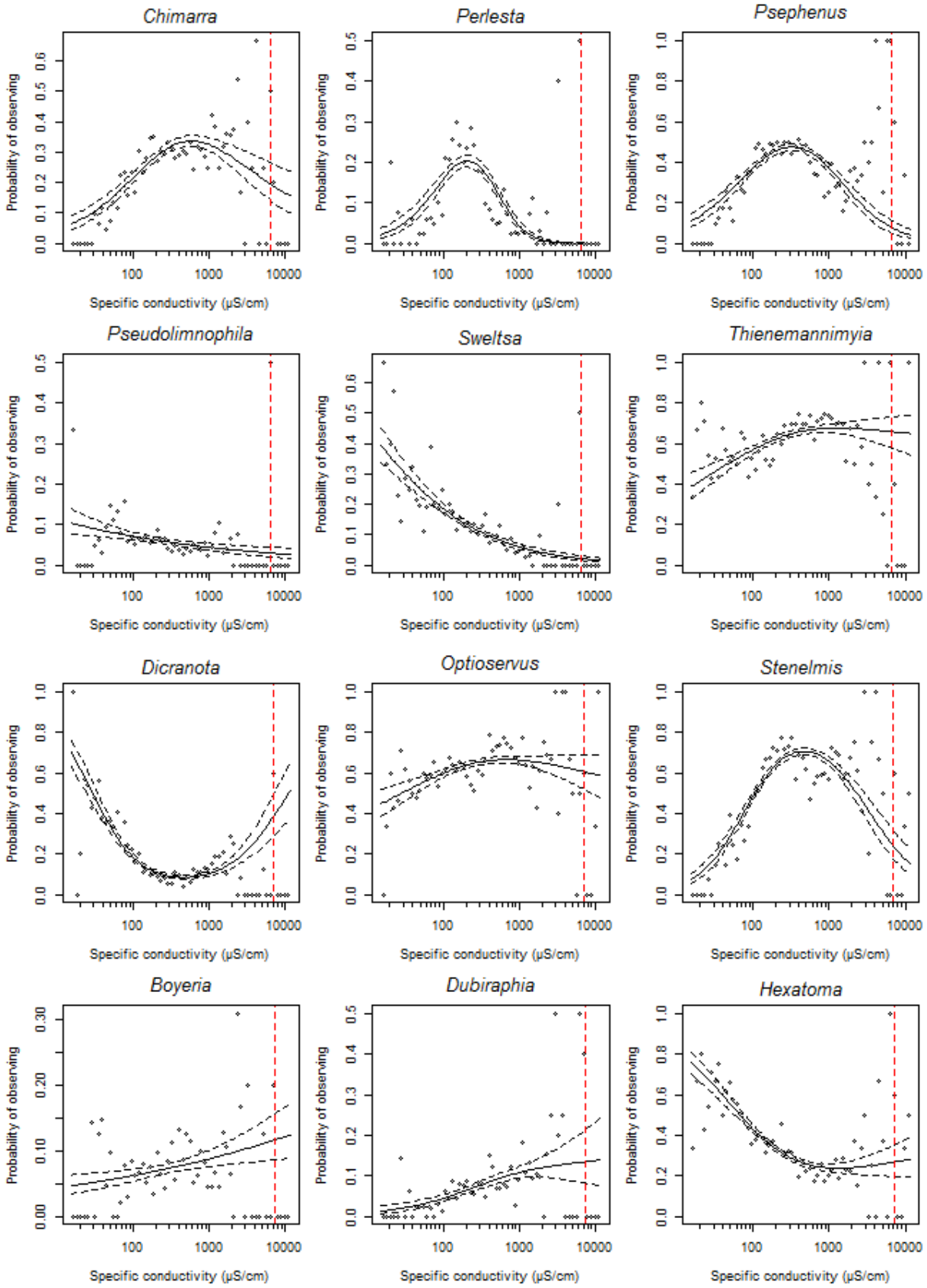

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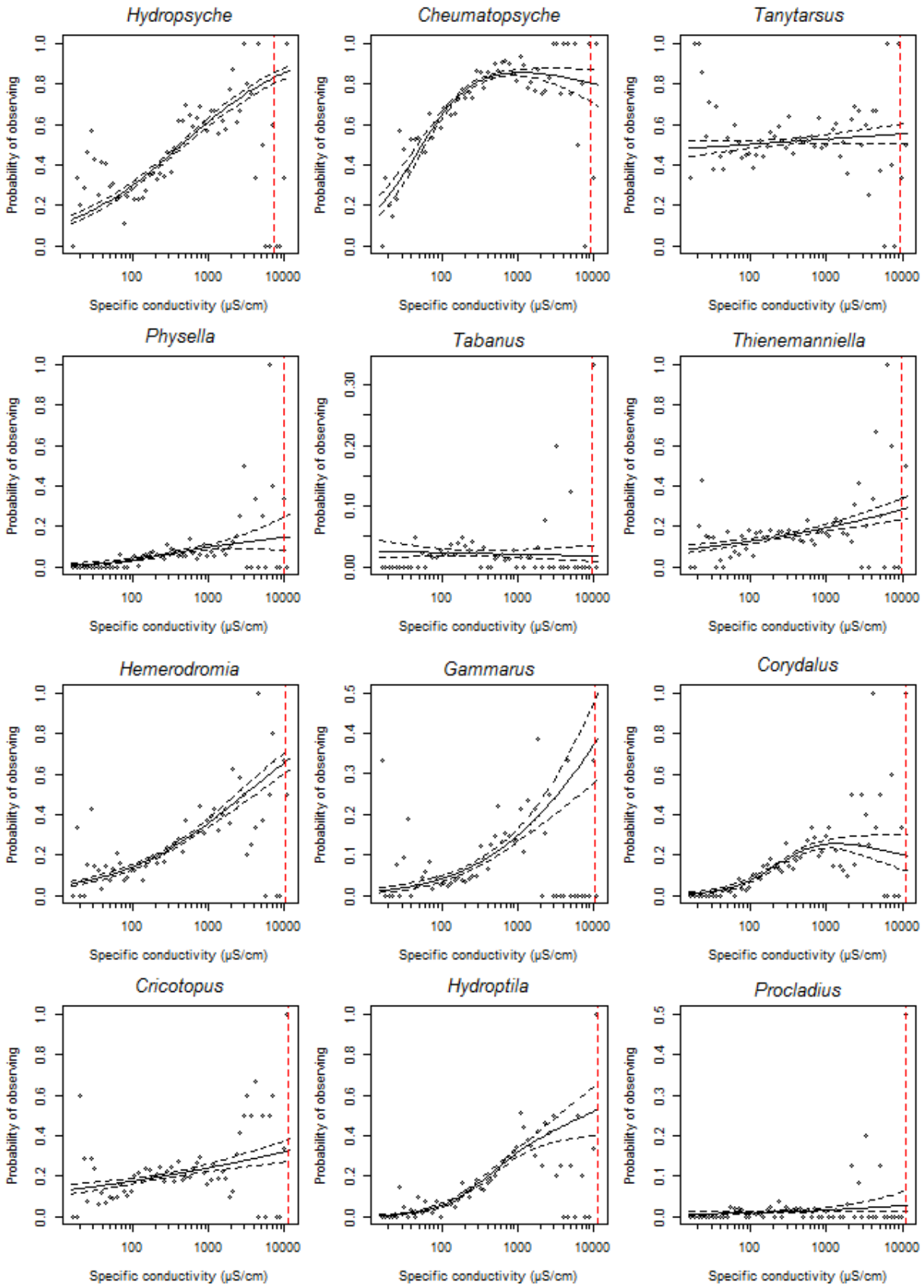

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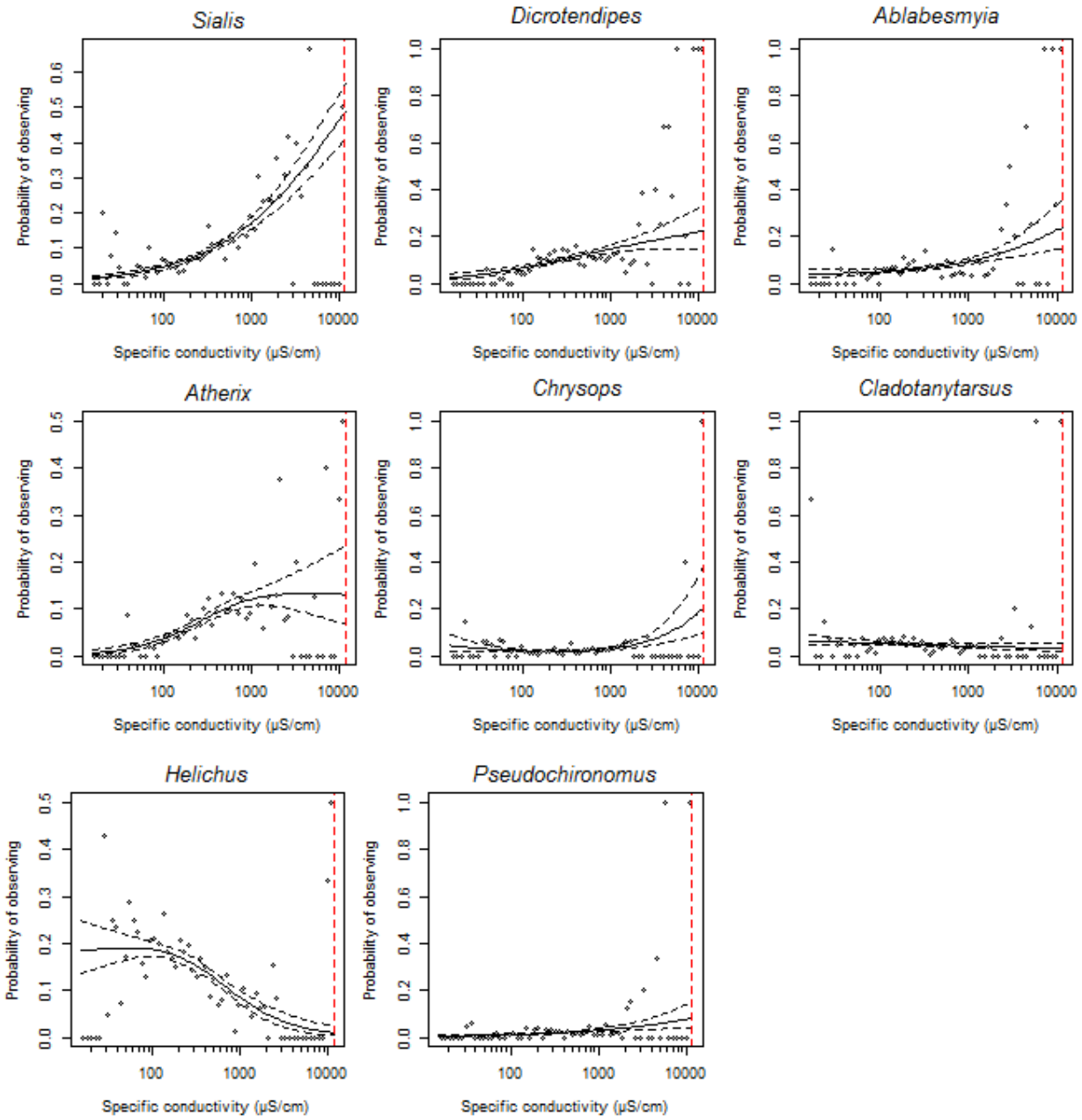

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E.4. CASE EXAMPLE ECOREGION 69−70 CUMULATIVE DISTRIBUTION FUNCTION (CDF) PLOTS

The CDFs used to derive the XC_{95} values are shown in this Appendix (see Section E.4). Conductivity is reported as specific conductivity. The red, dashed vertical line is the XC_{95} value for the genus listed in this Appendix (see Section E.2) obtained from each plotted CDF in this Appendix (see Section E.4). Plots are arranged from the lowest to the highest XC_{95} value.

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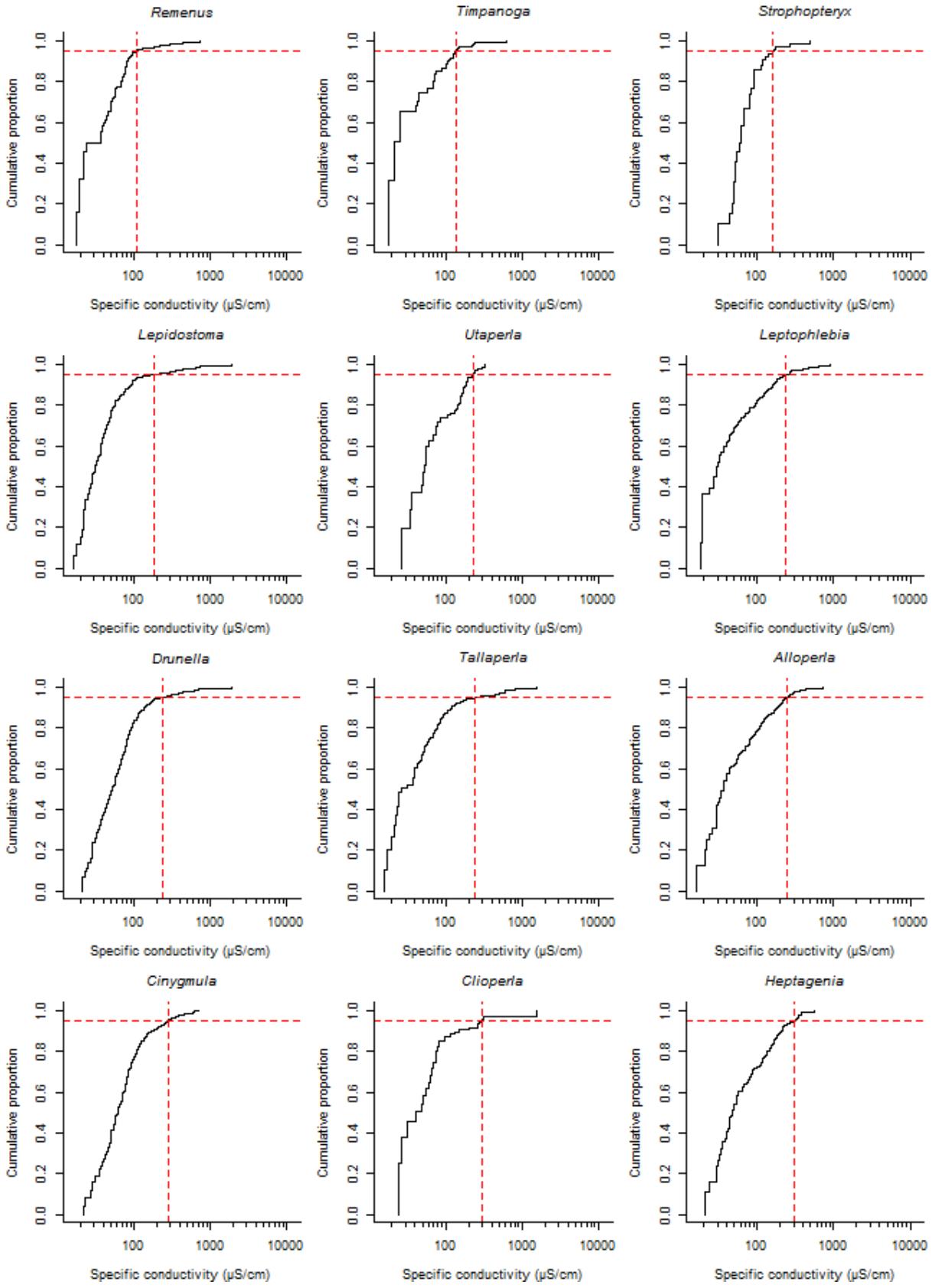

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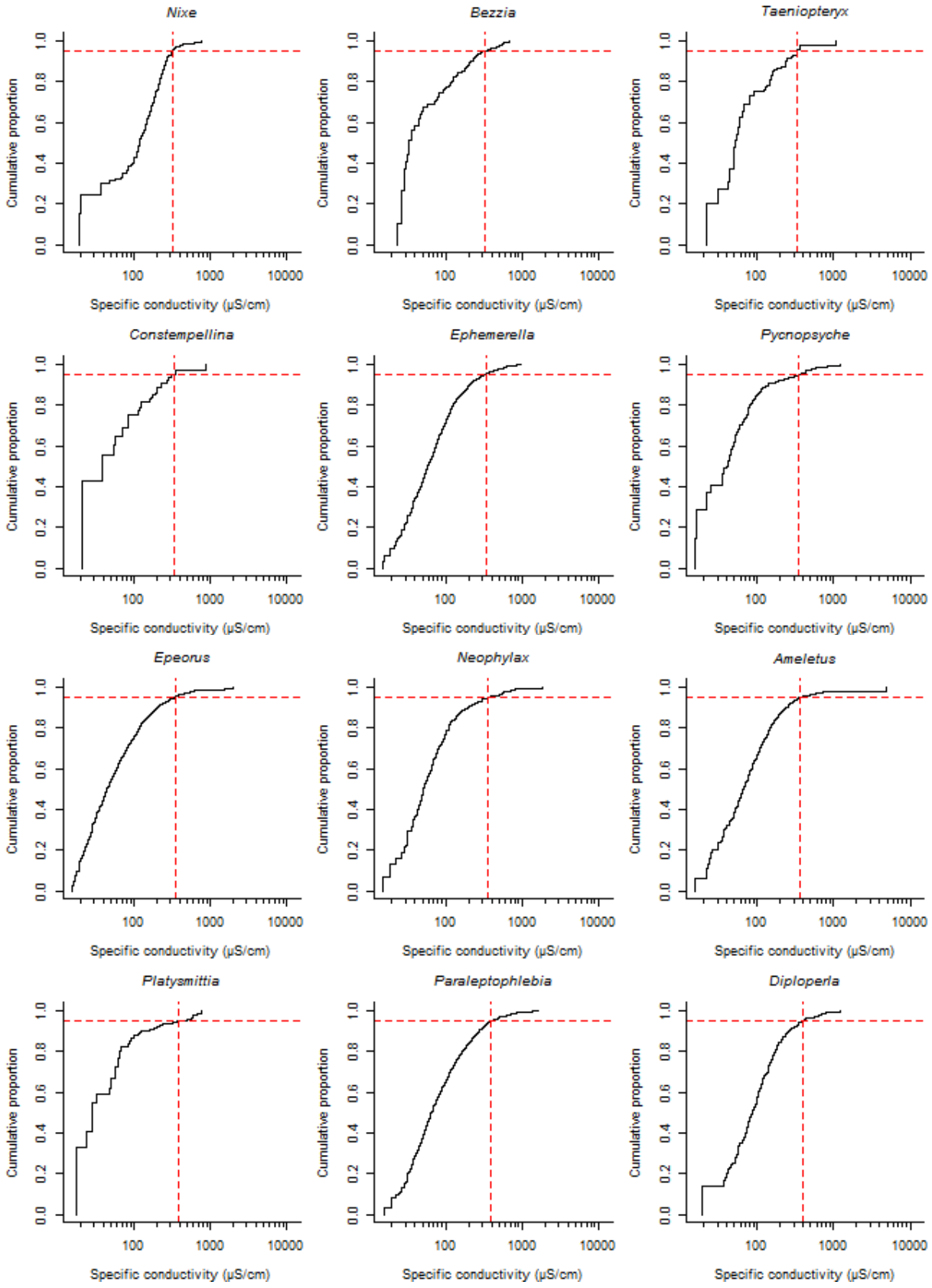

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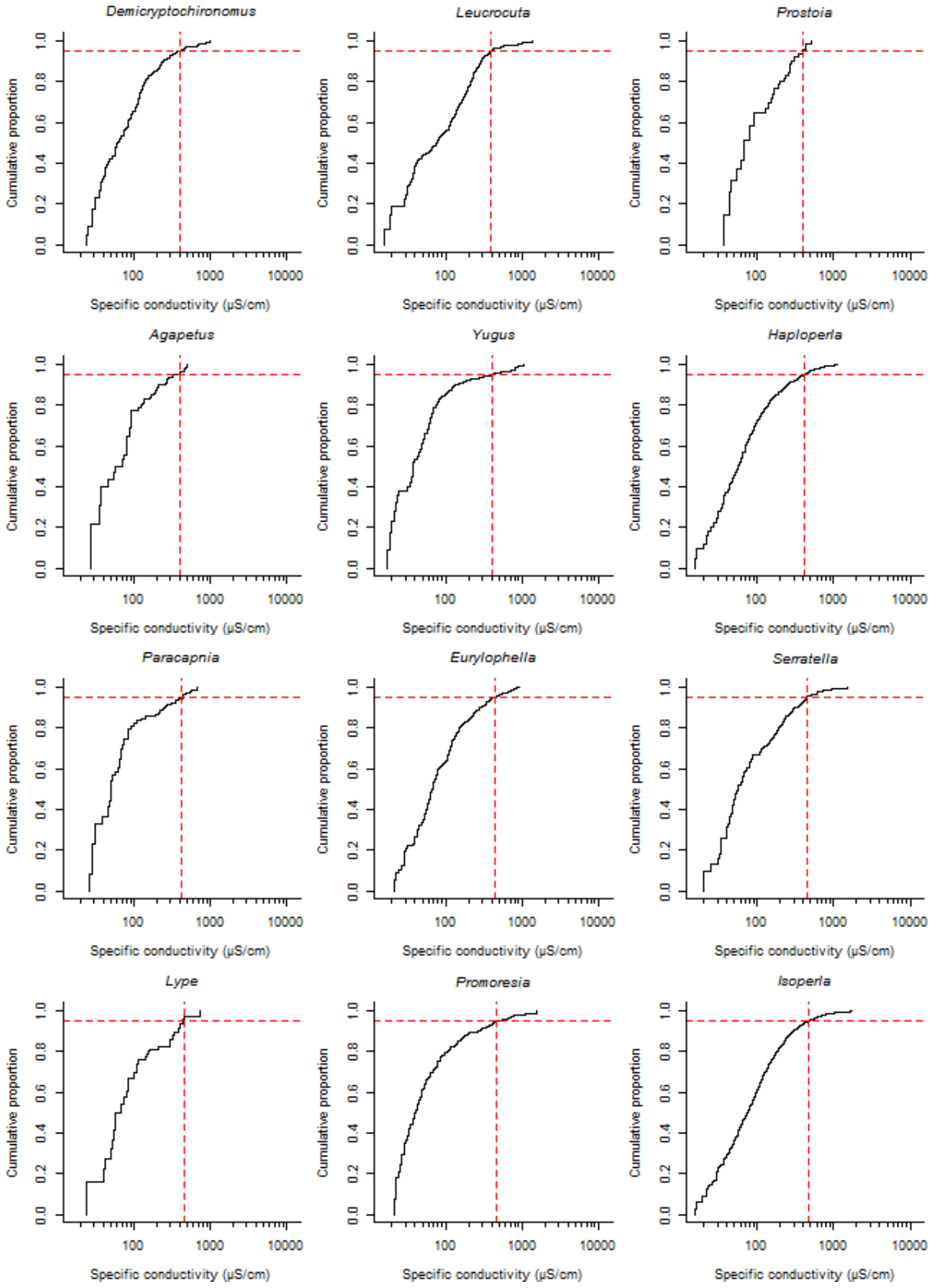

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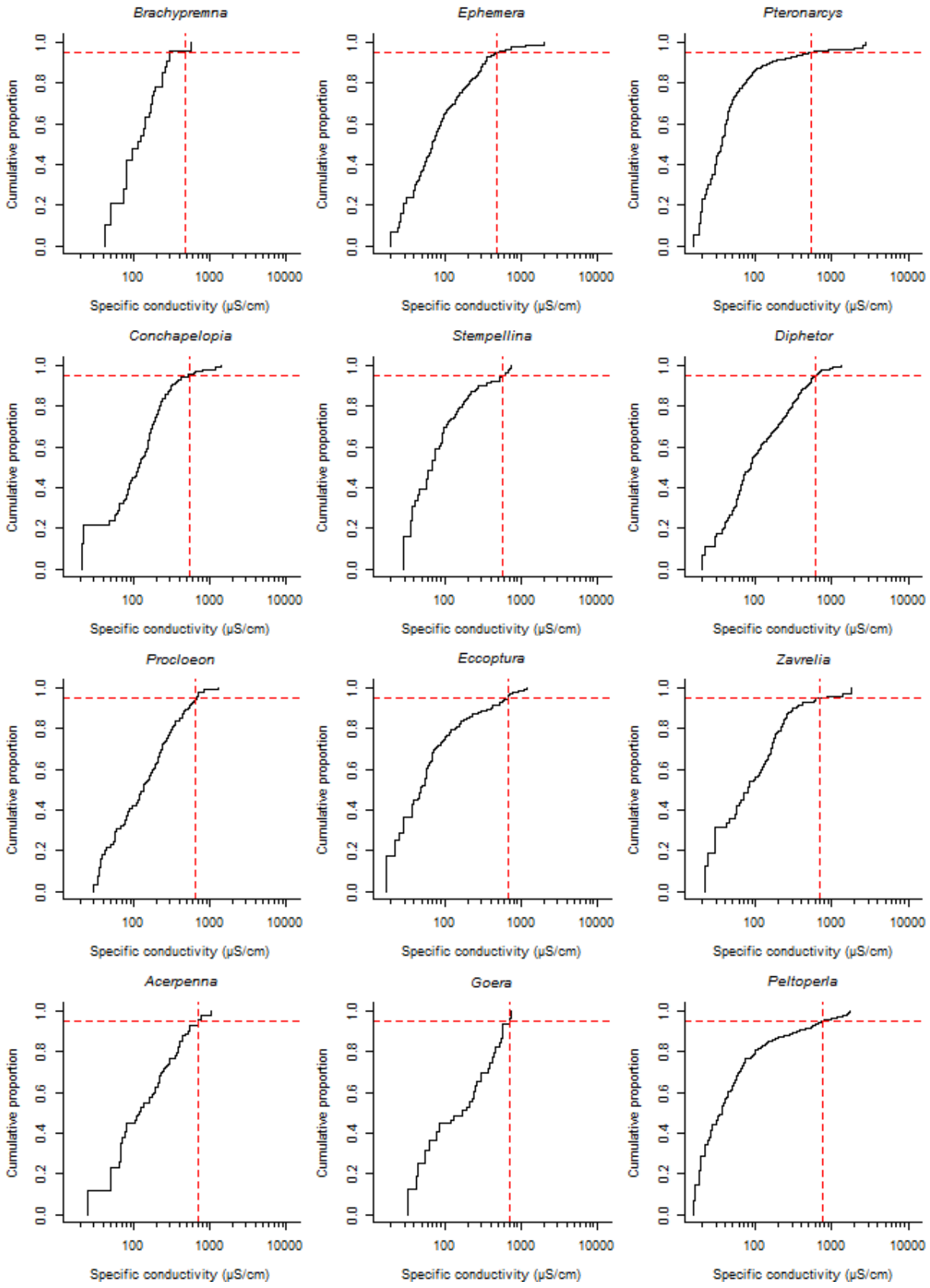

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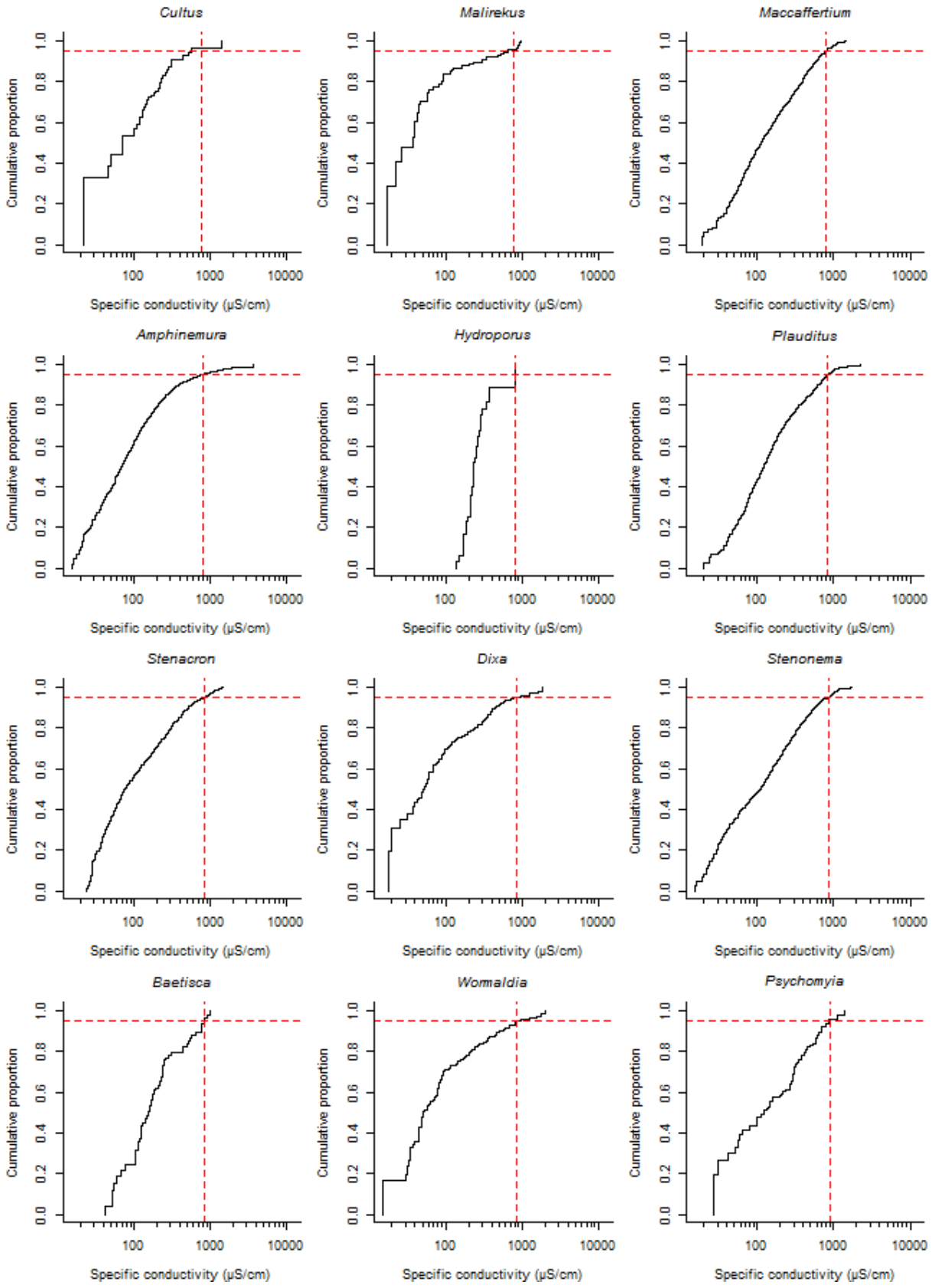

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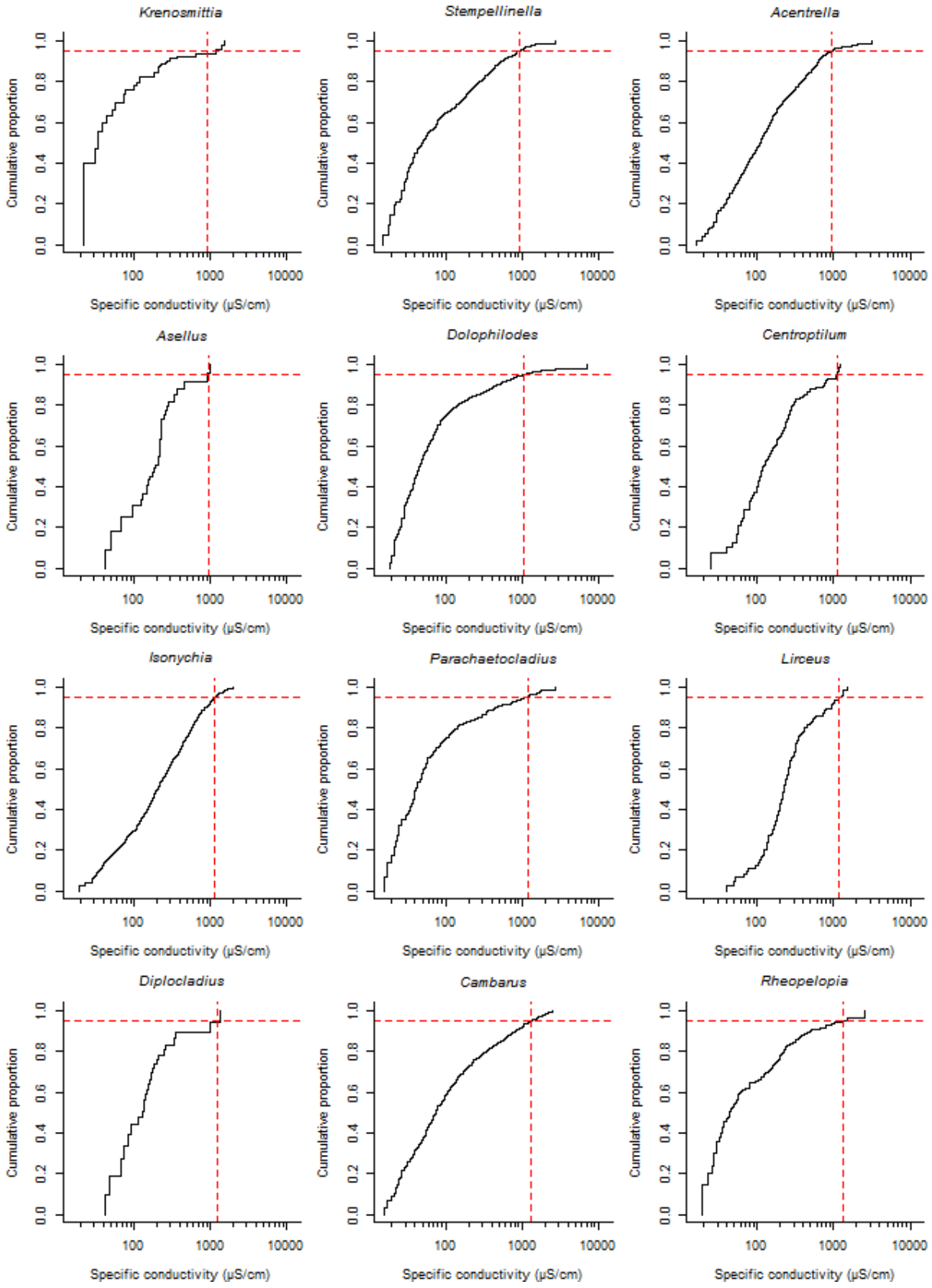

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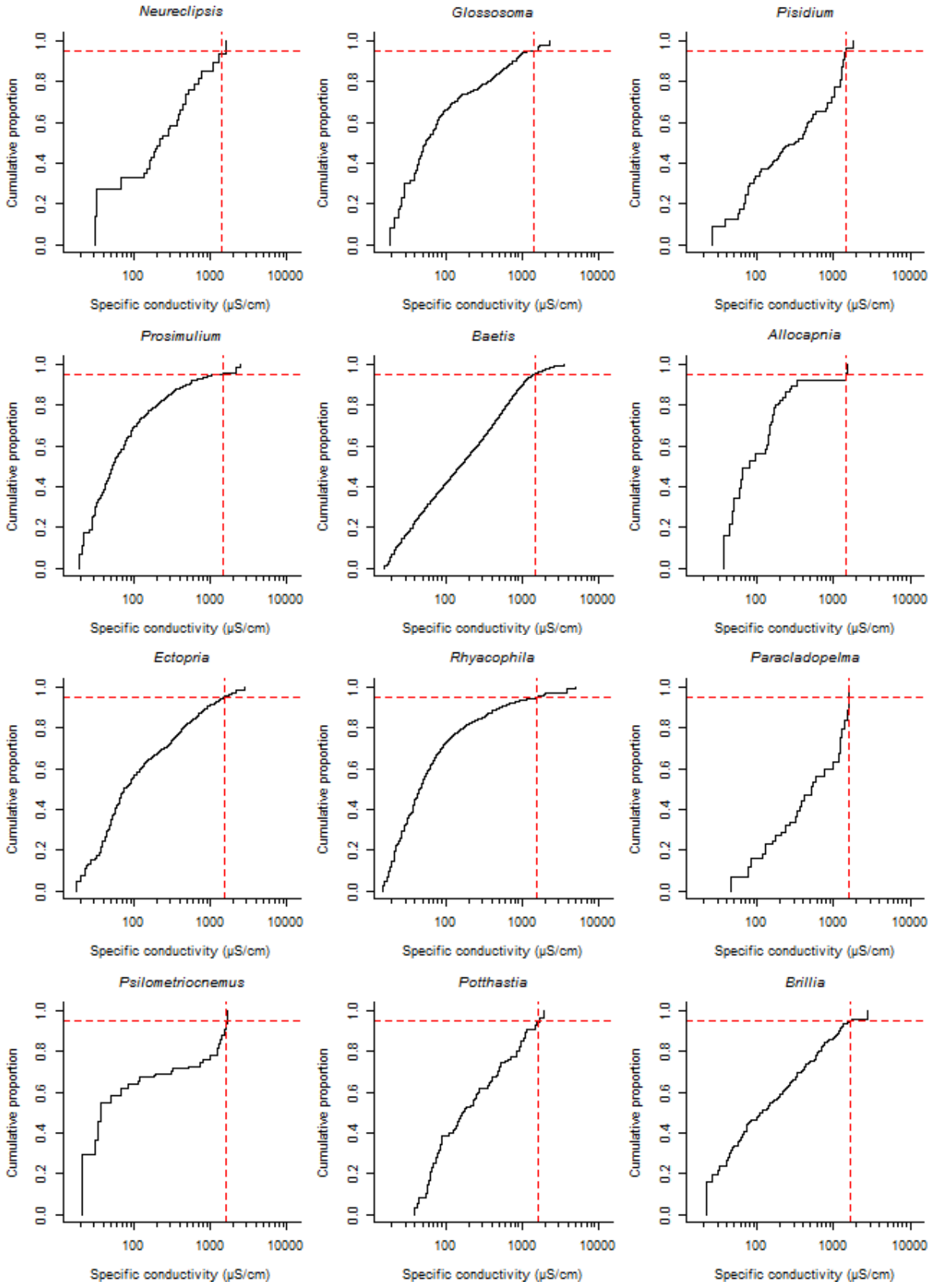

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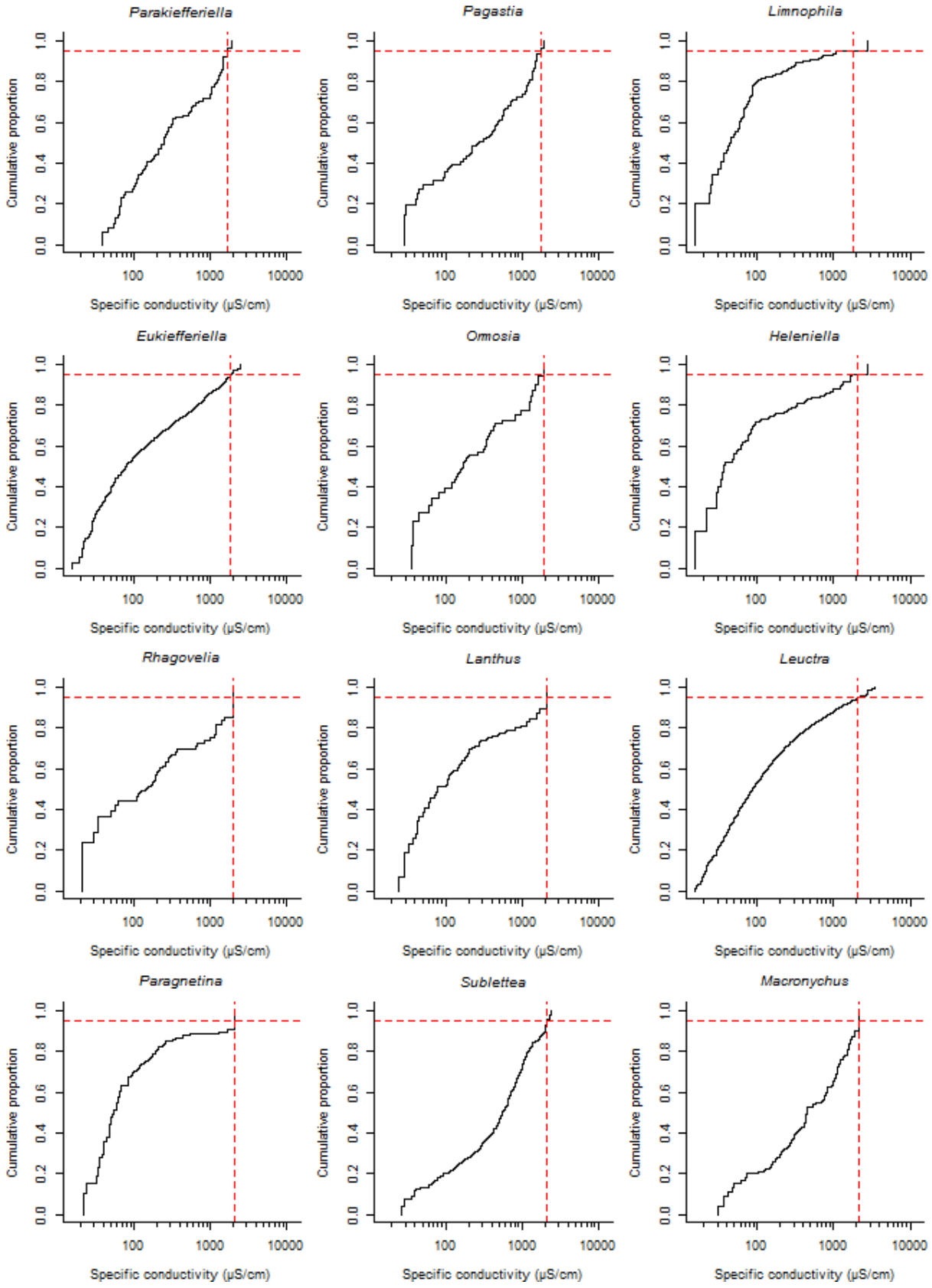

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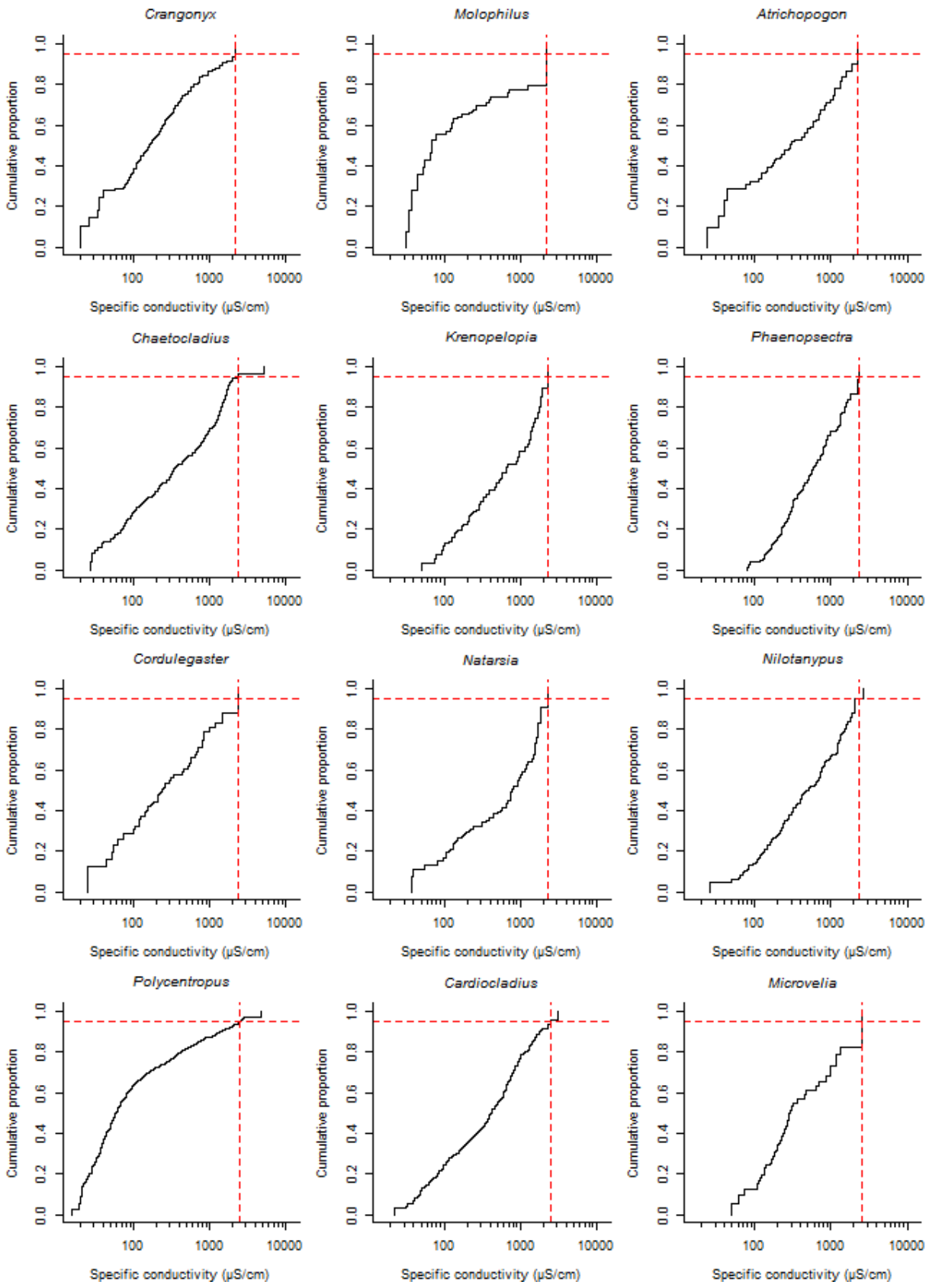

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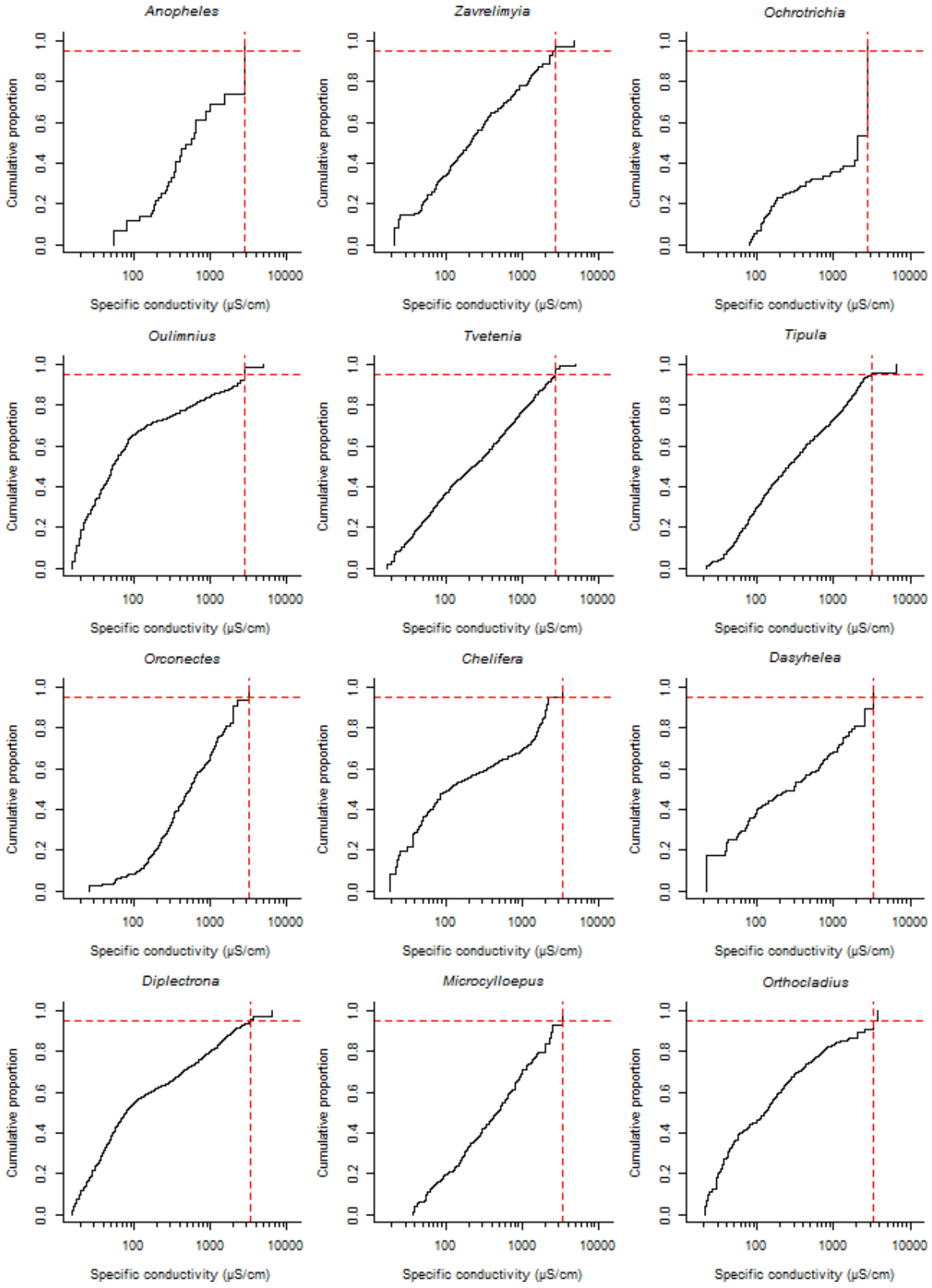

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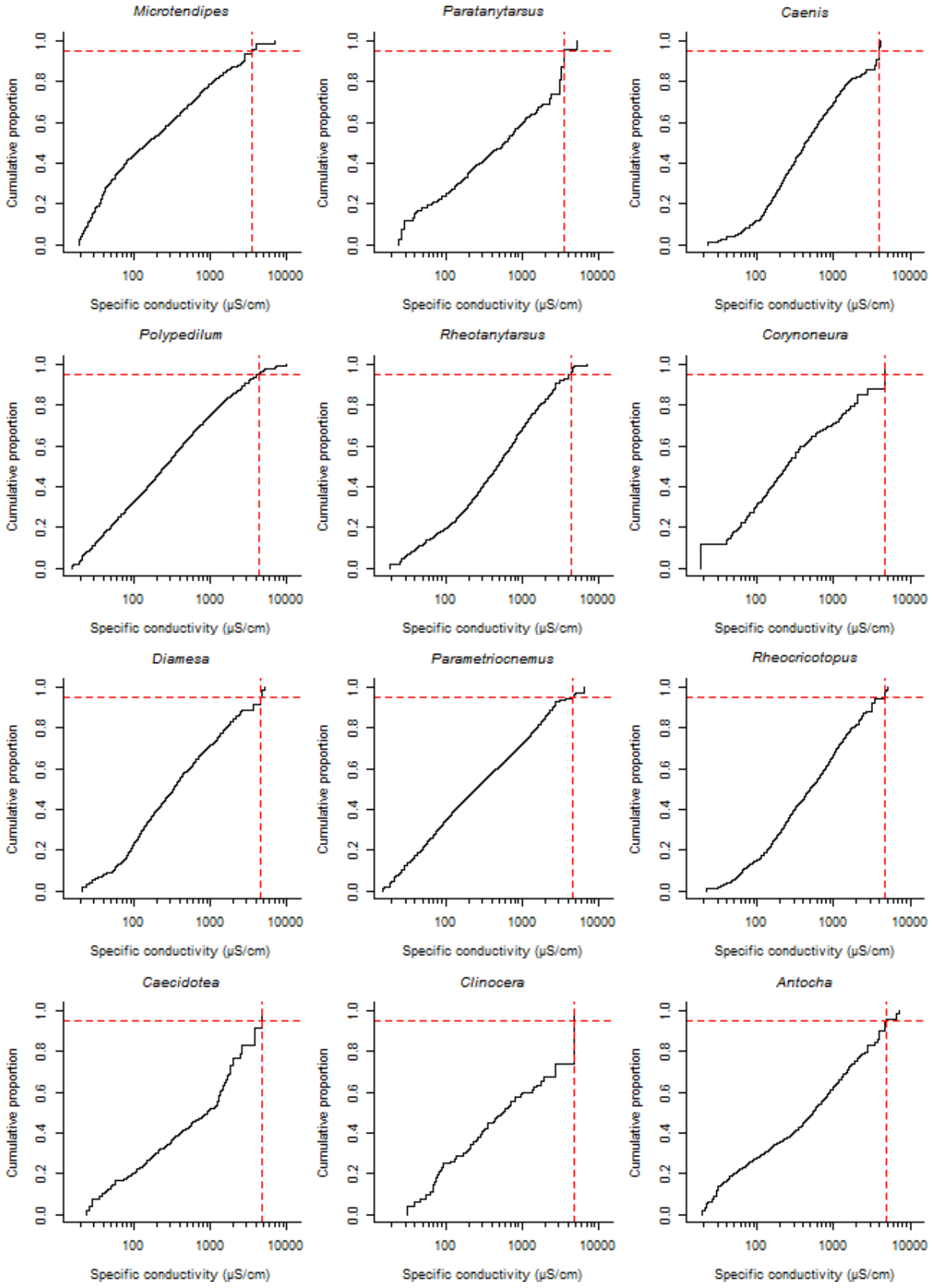

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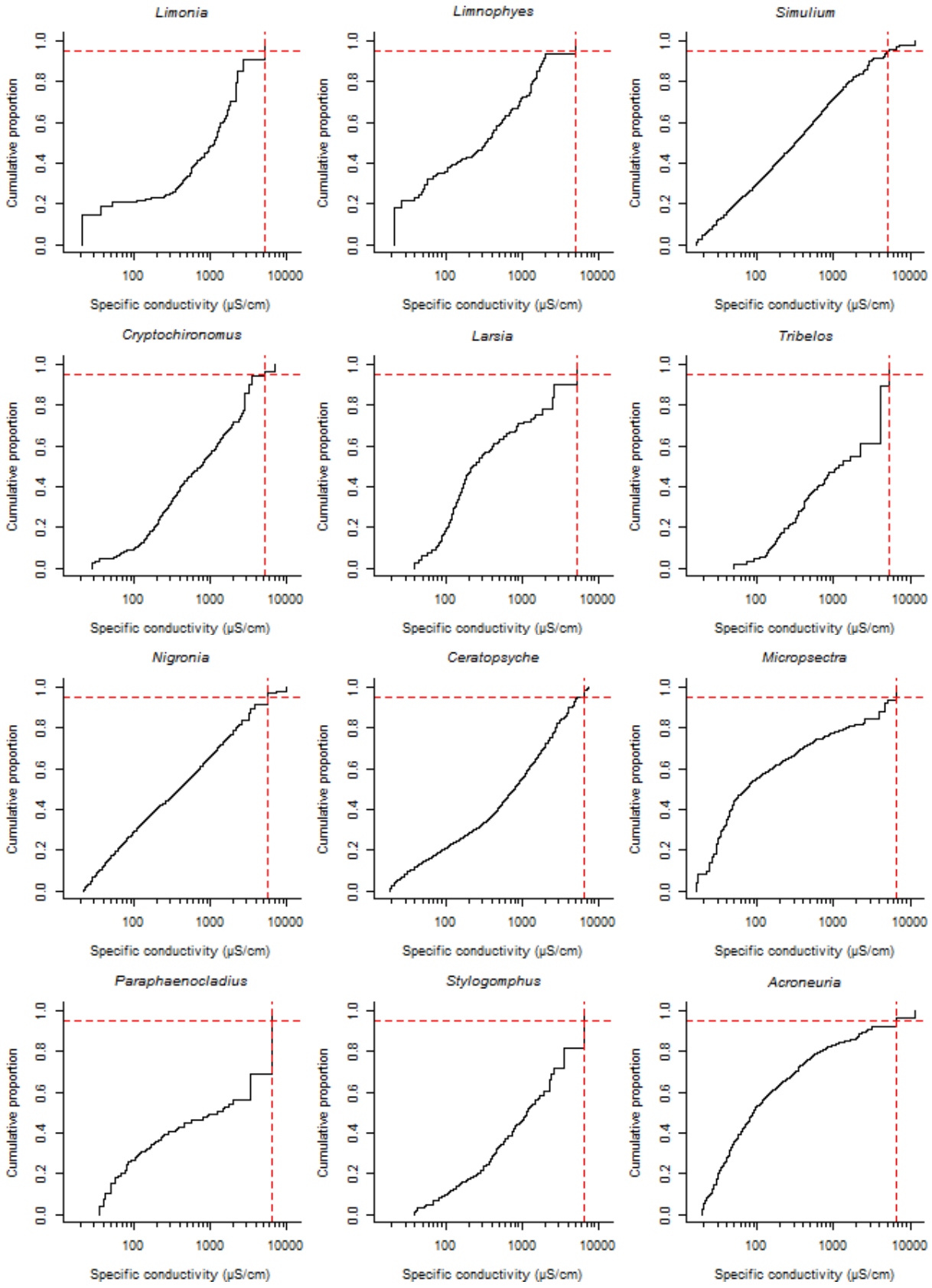

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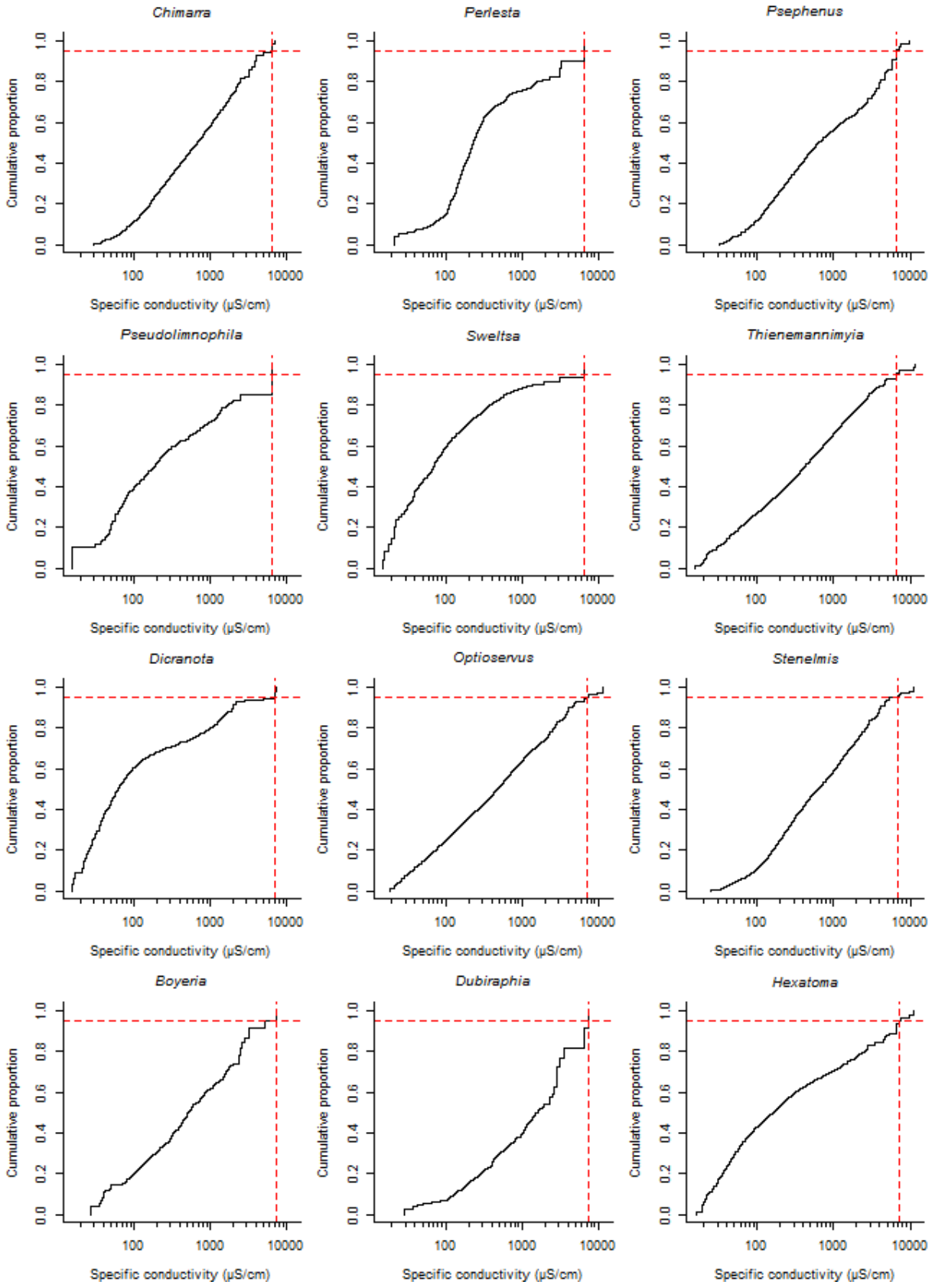

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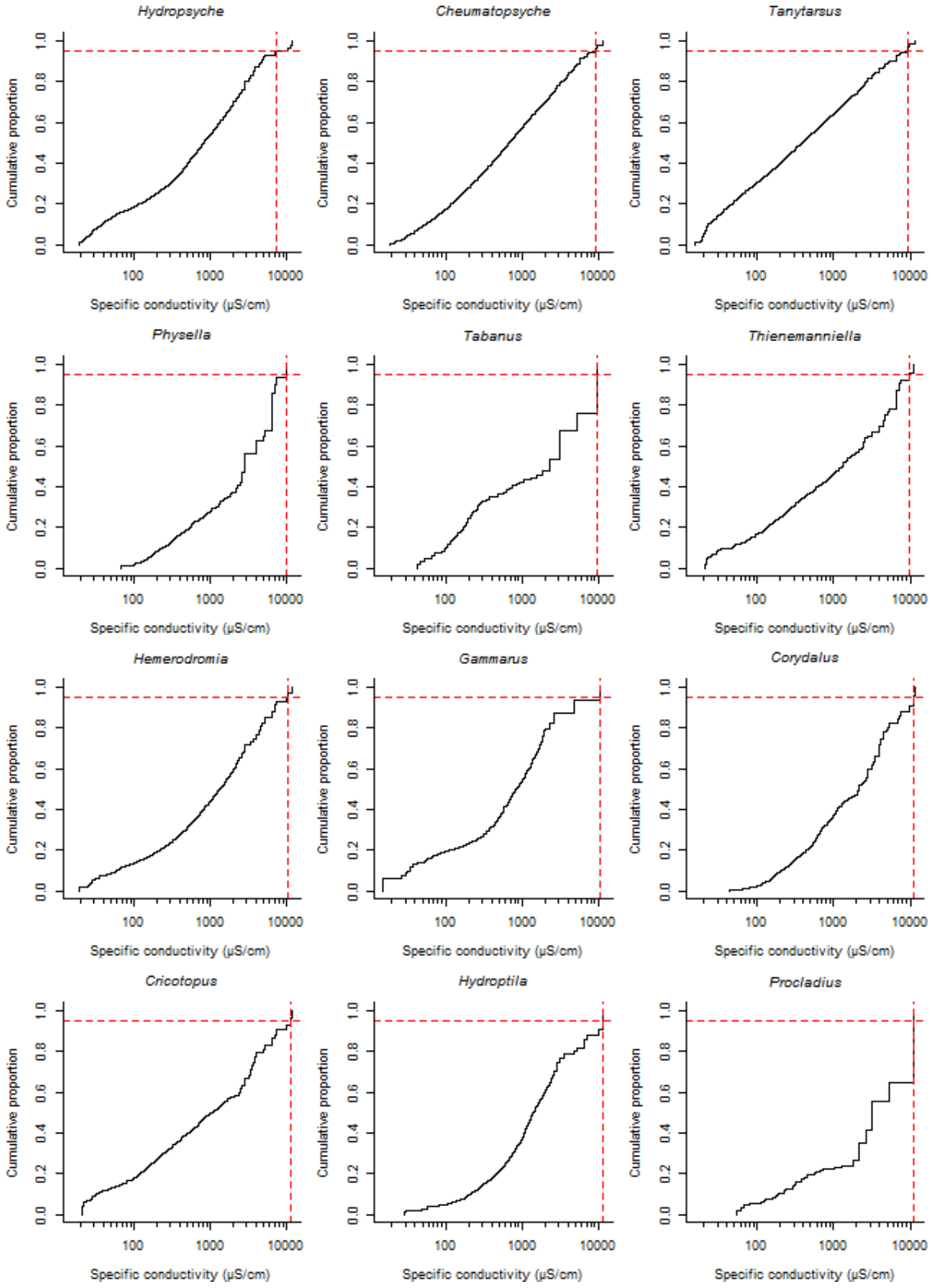

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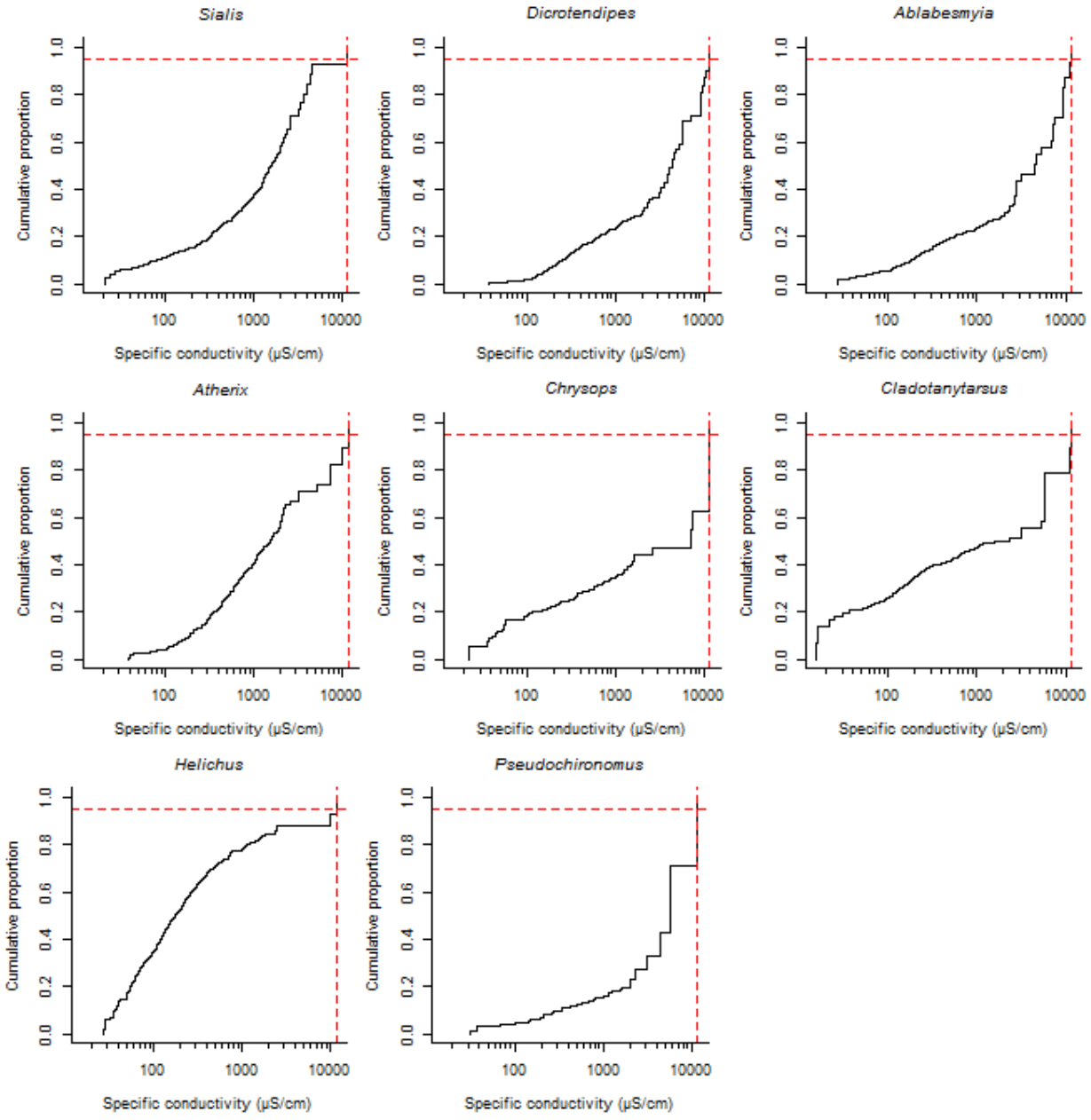

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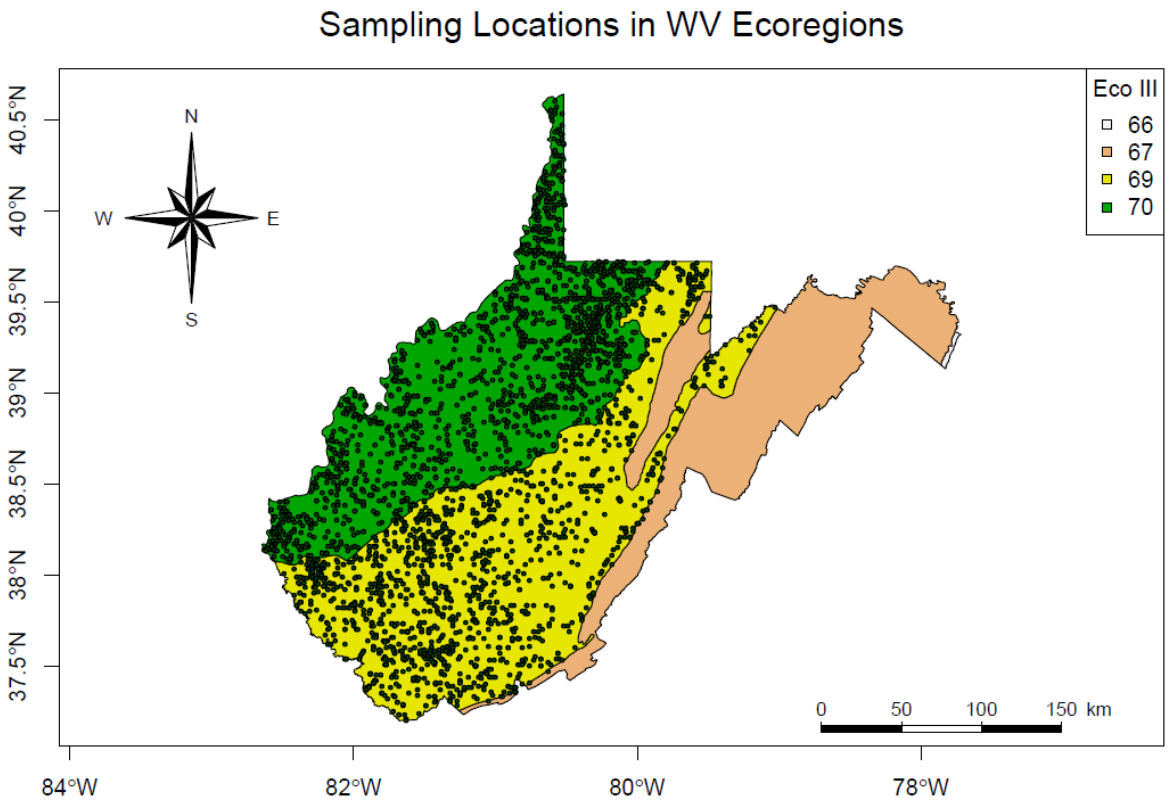
E.5. CASE EXAMPLE ECOREGION 69−70 SAMPLING LOCATIONS OF GENERA

The geographical location where 462 genera observed in Ecoregions 69 and 70 in West Virginia are shown including those observed as infrequently as a single observation. The geographical locations where each genus was observed in Ecoregions 69 and 70 are shown in the subsequent maps in this Appendix (see Section E.5)



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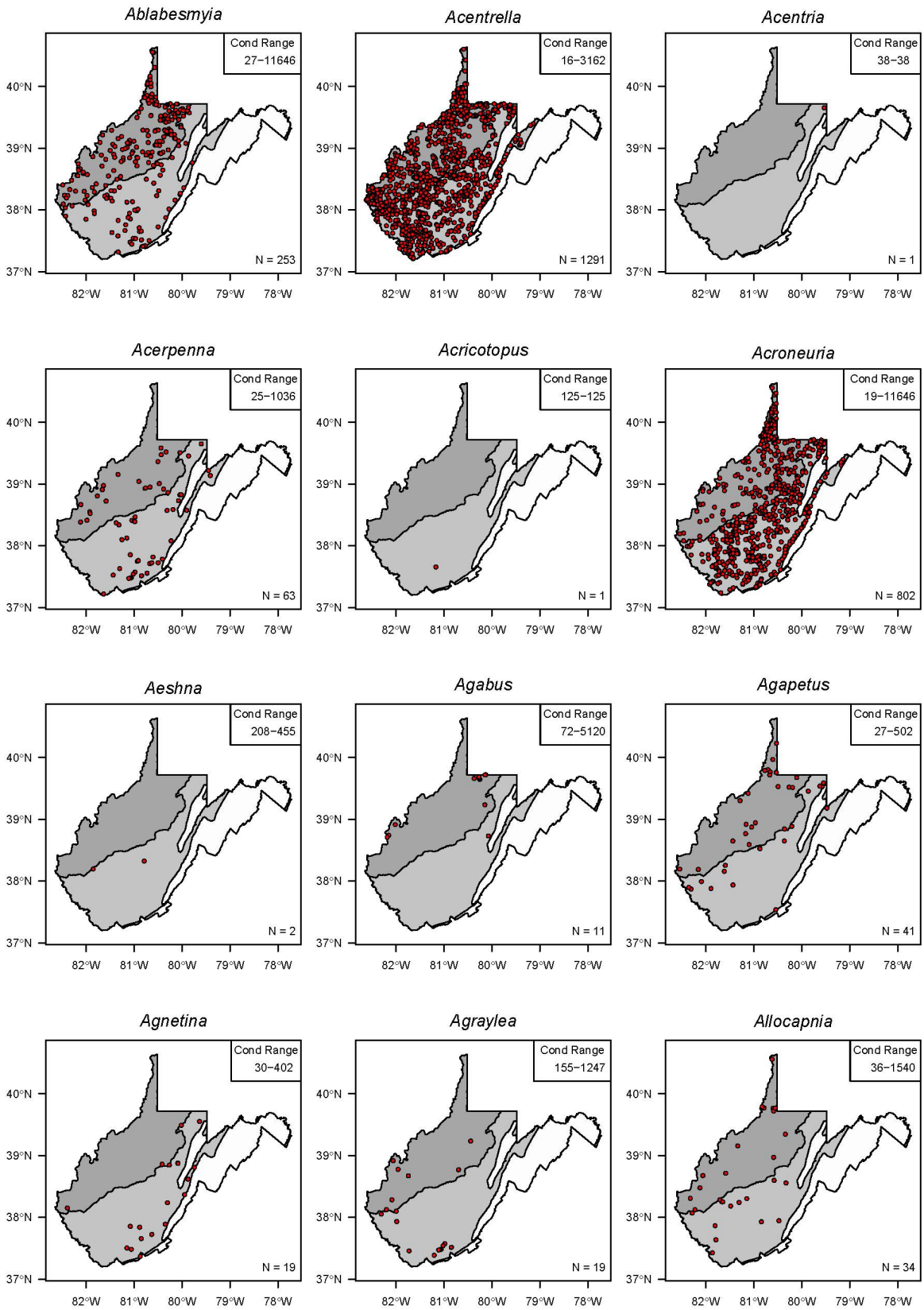

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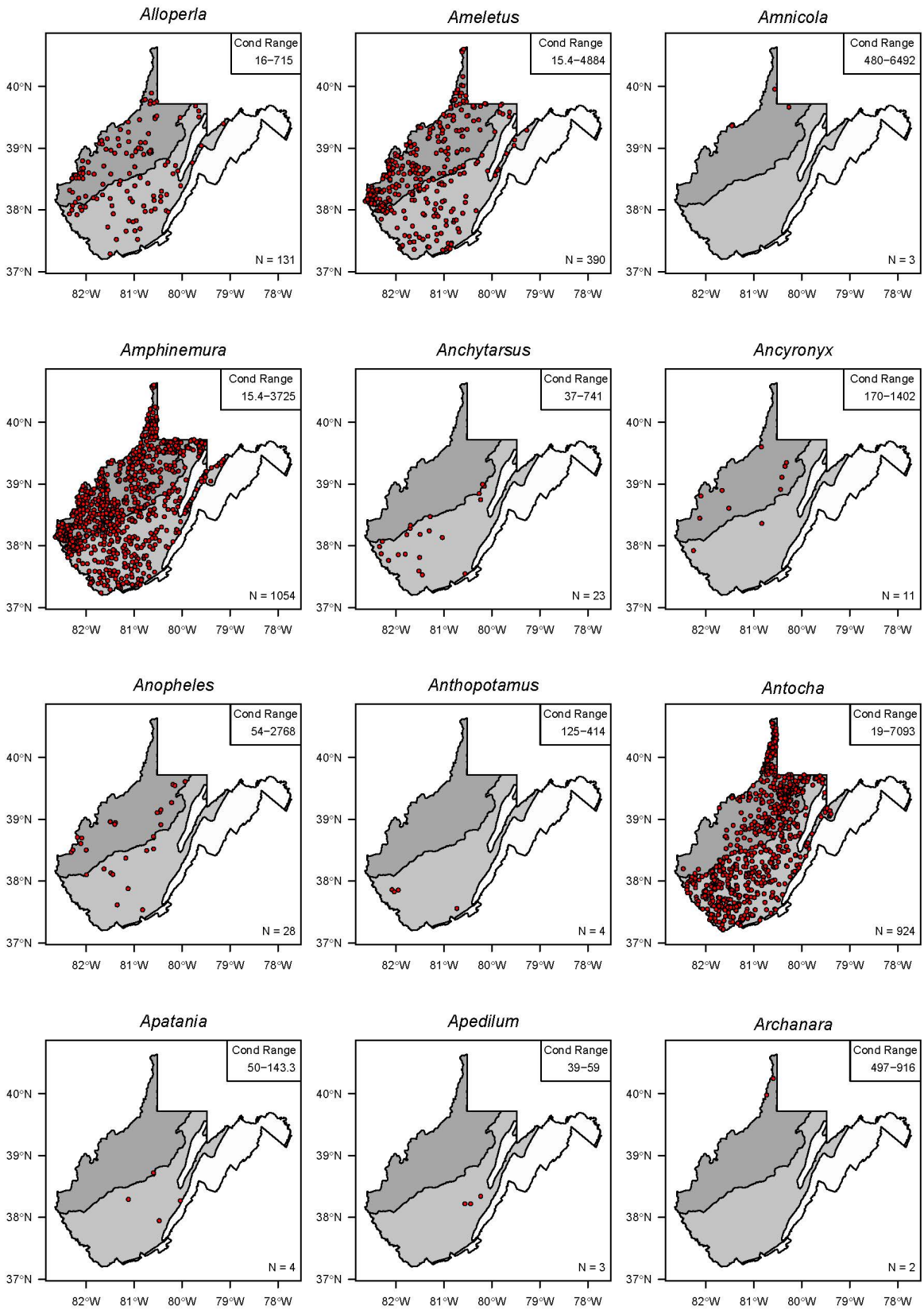

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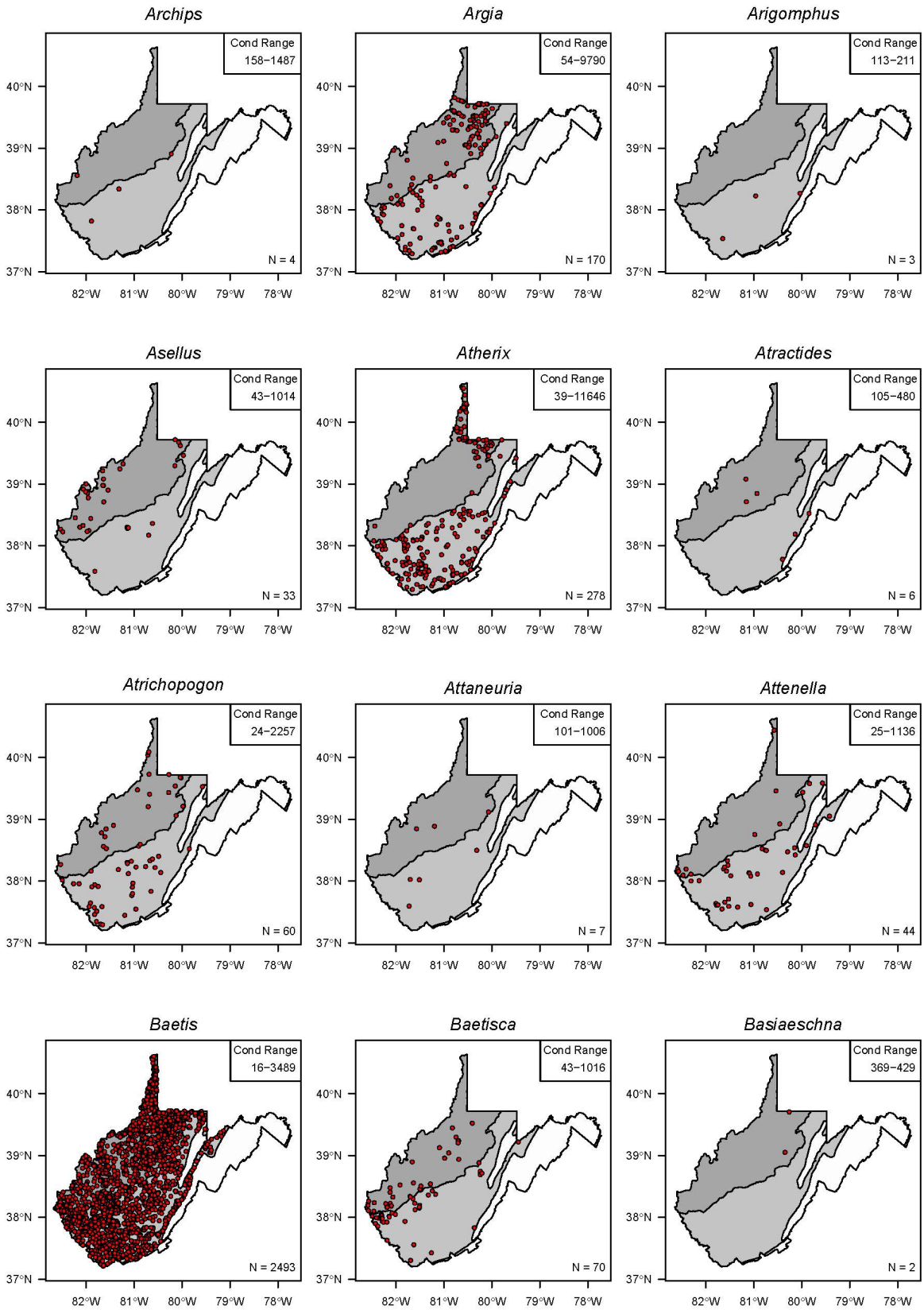

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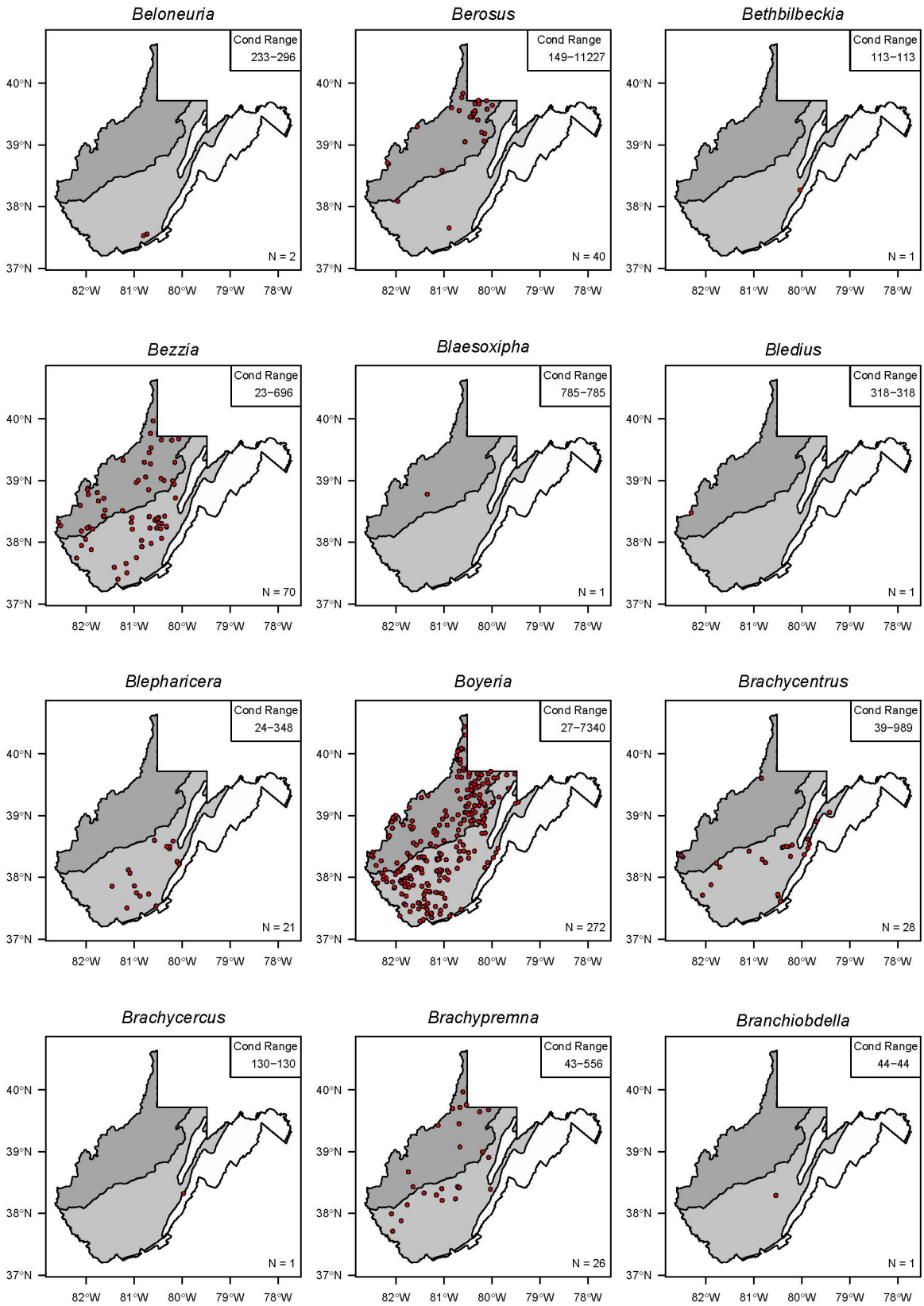

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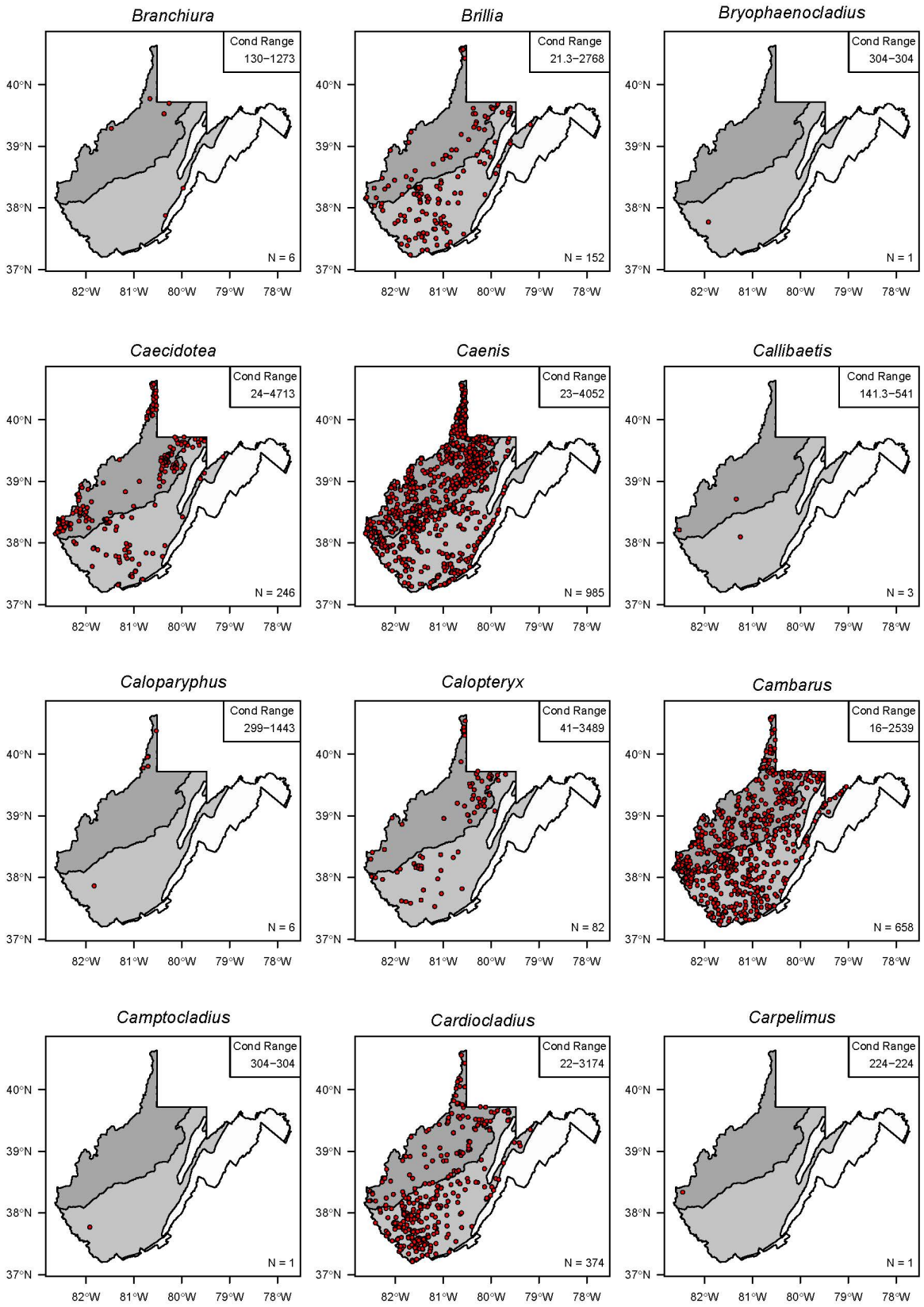

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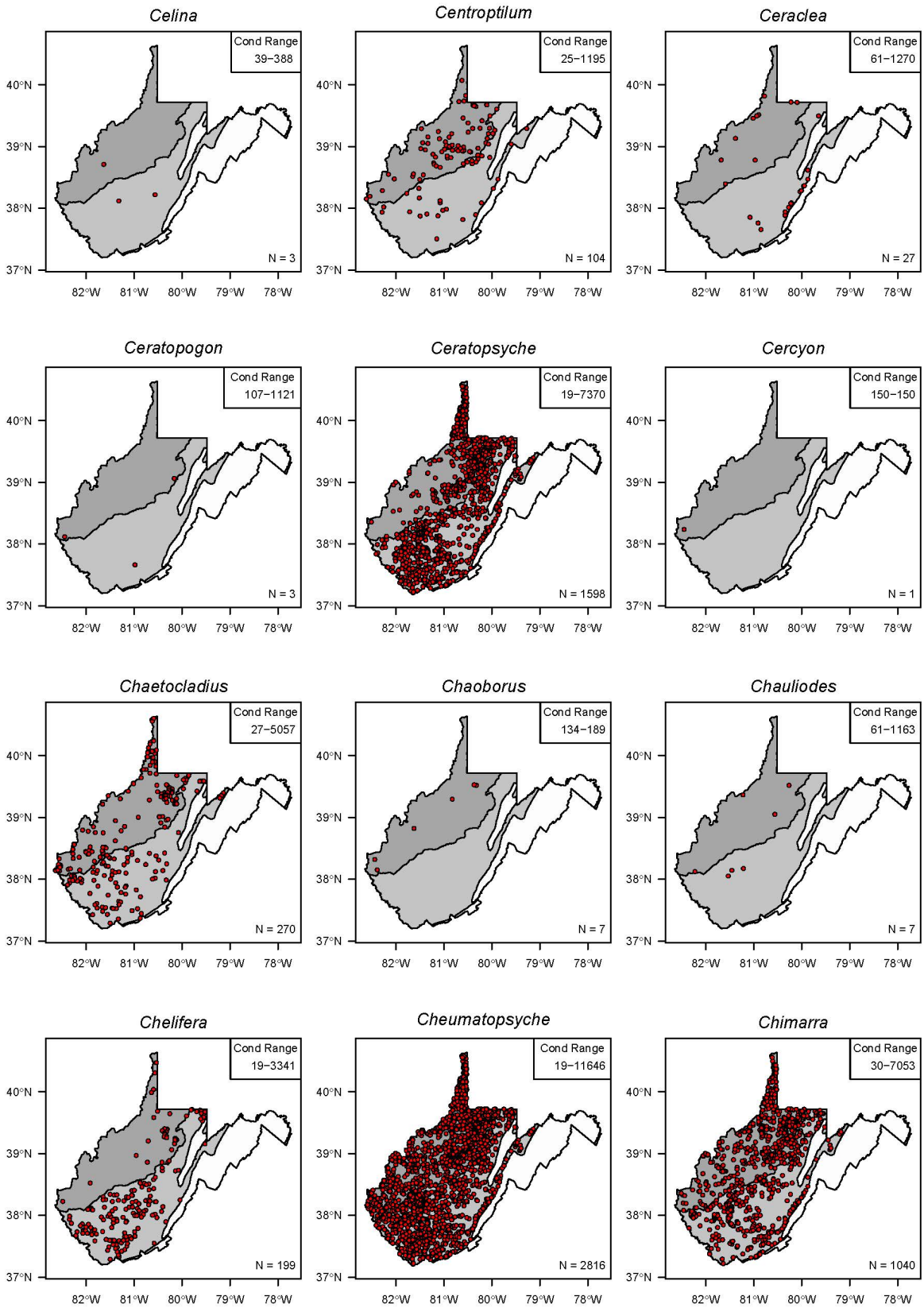

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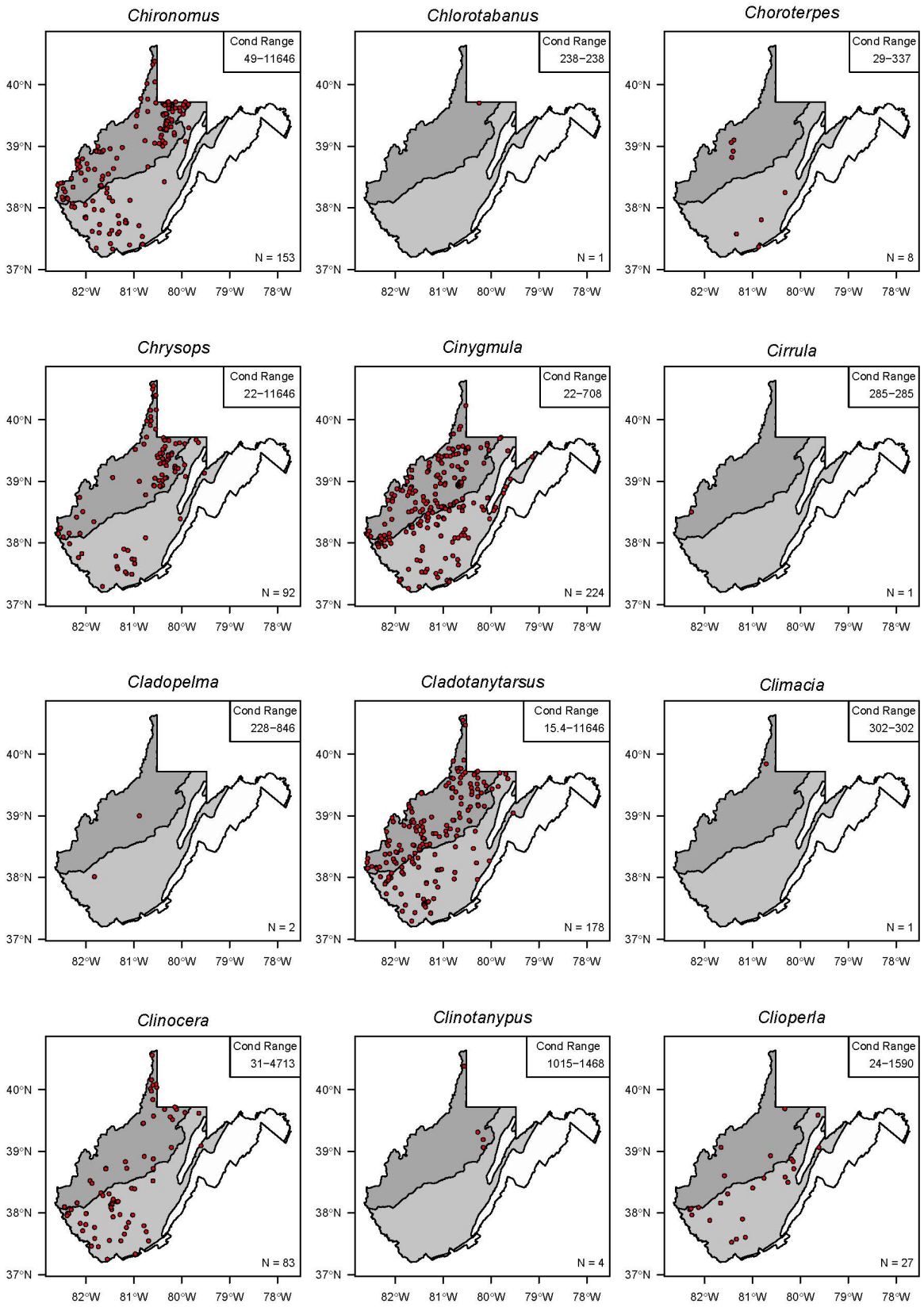

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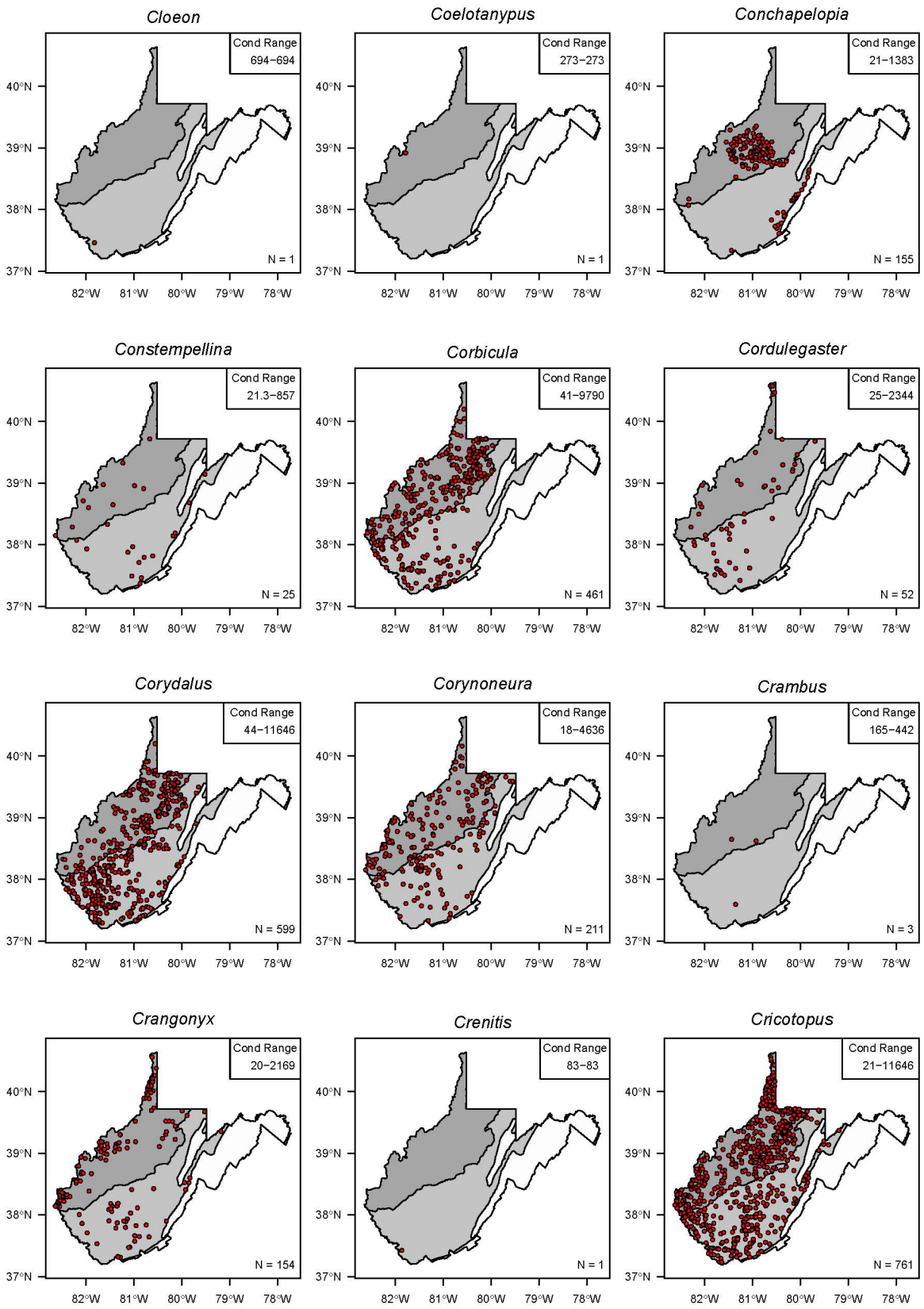

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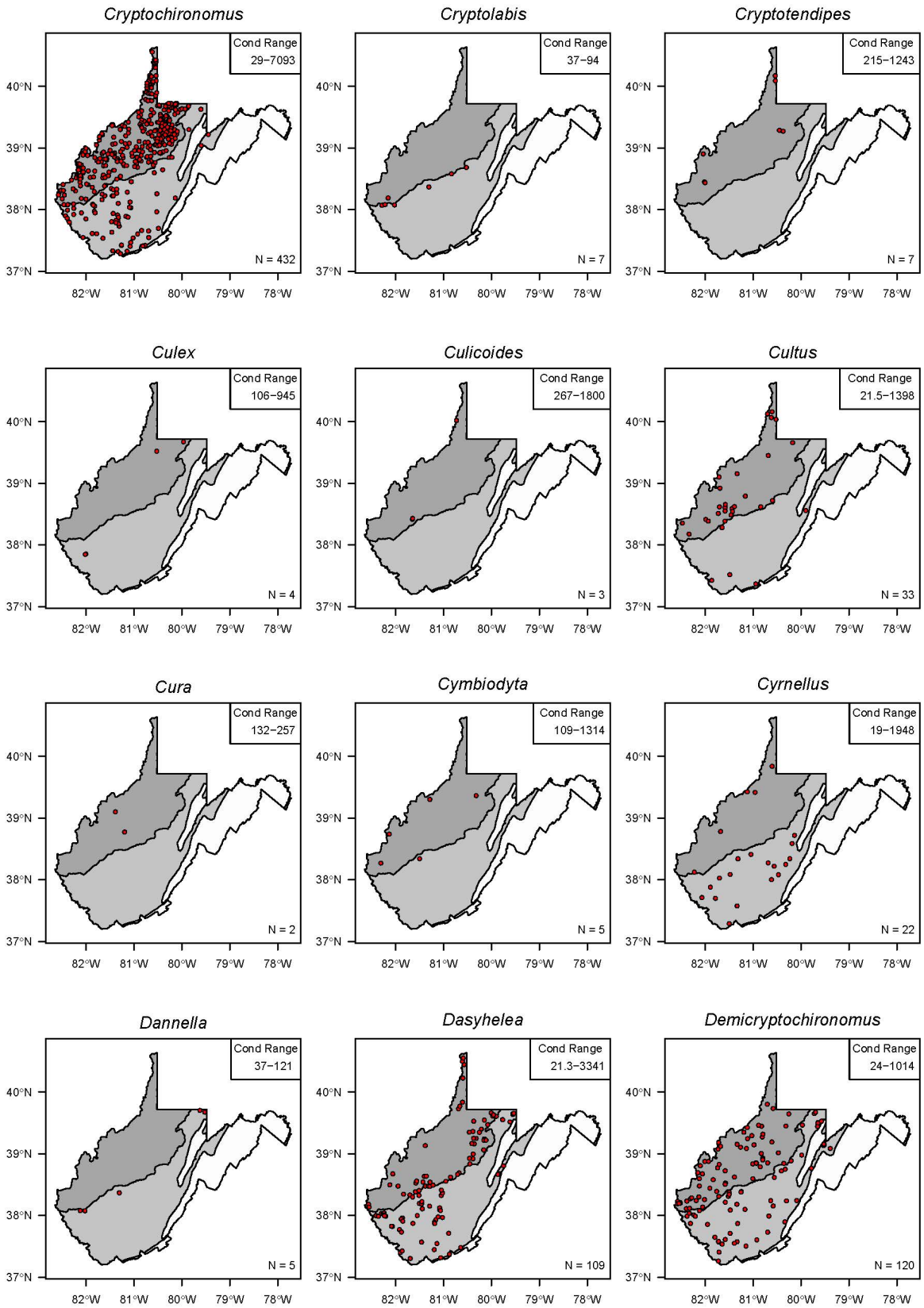

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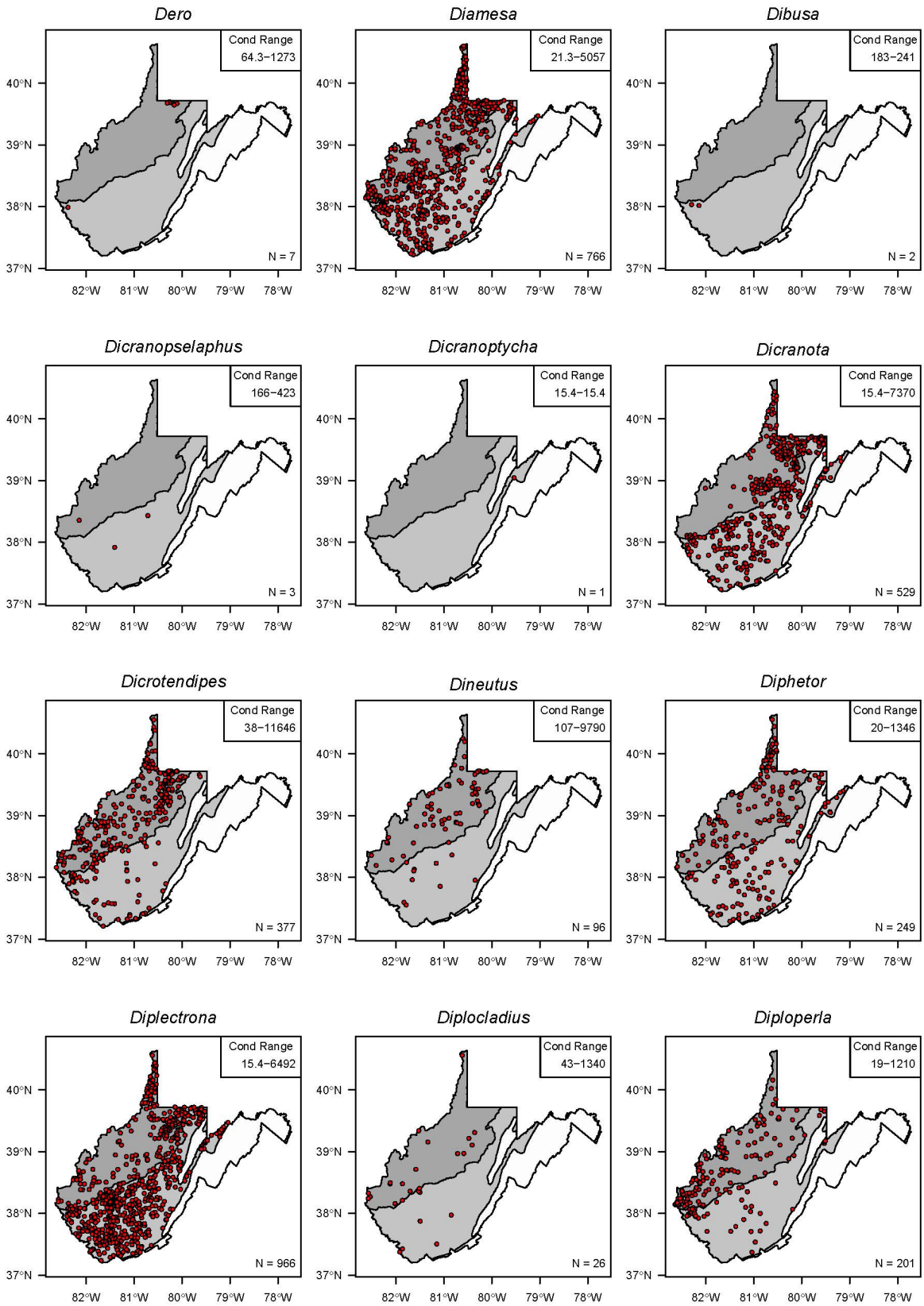

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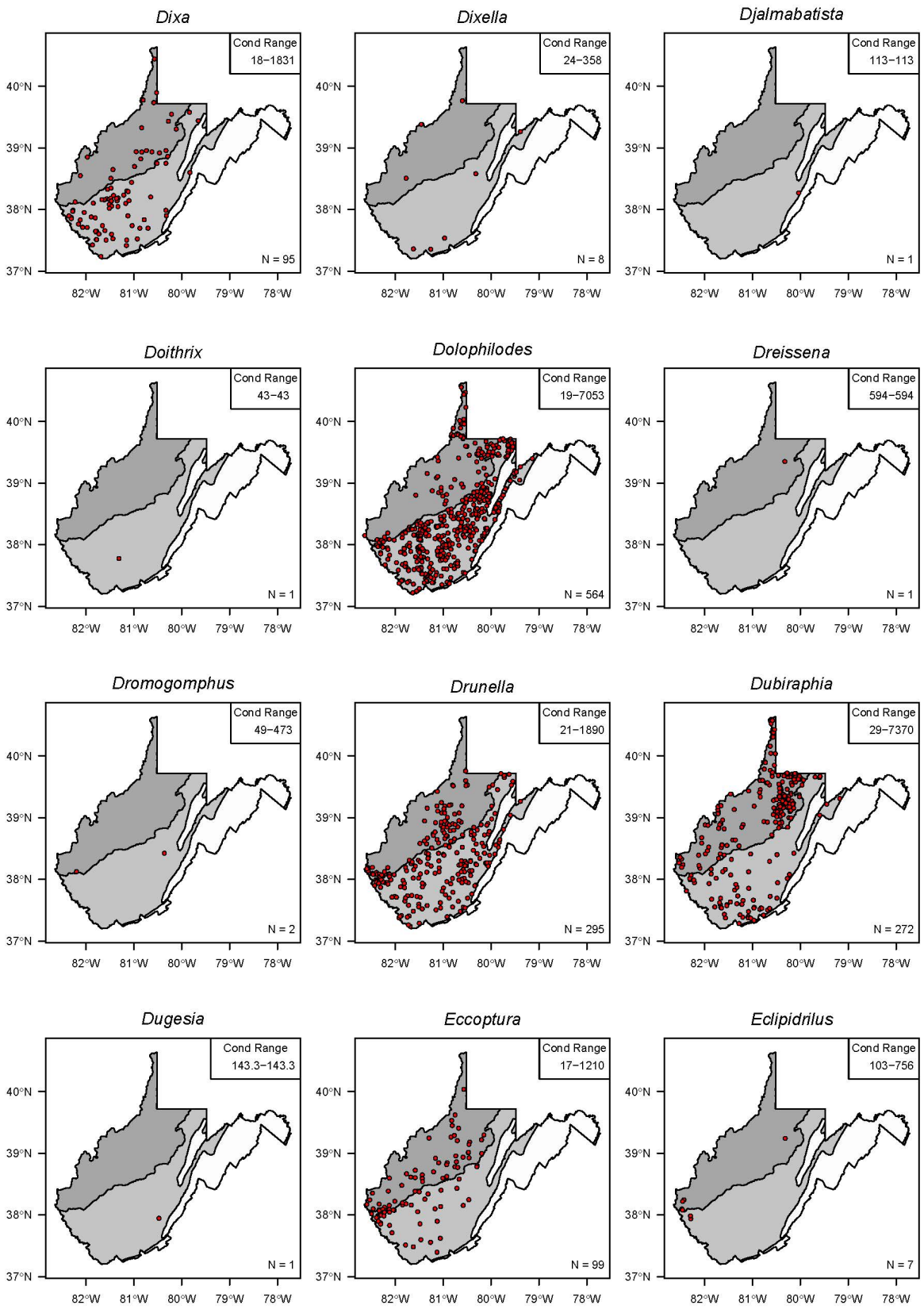

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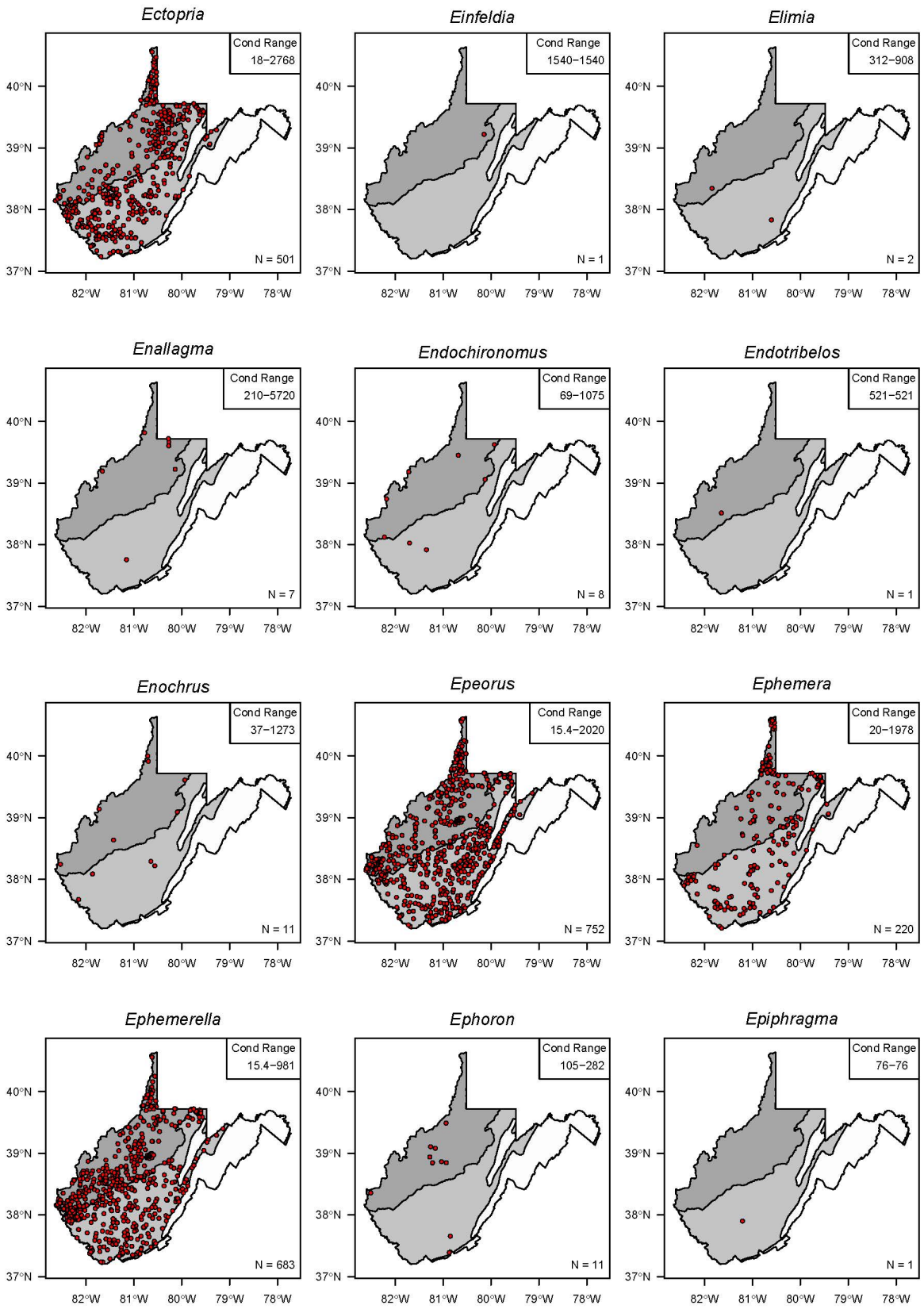

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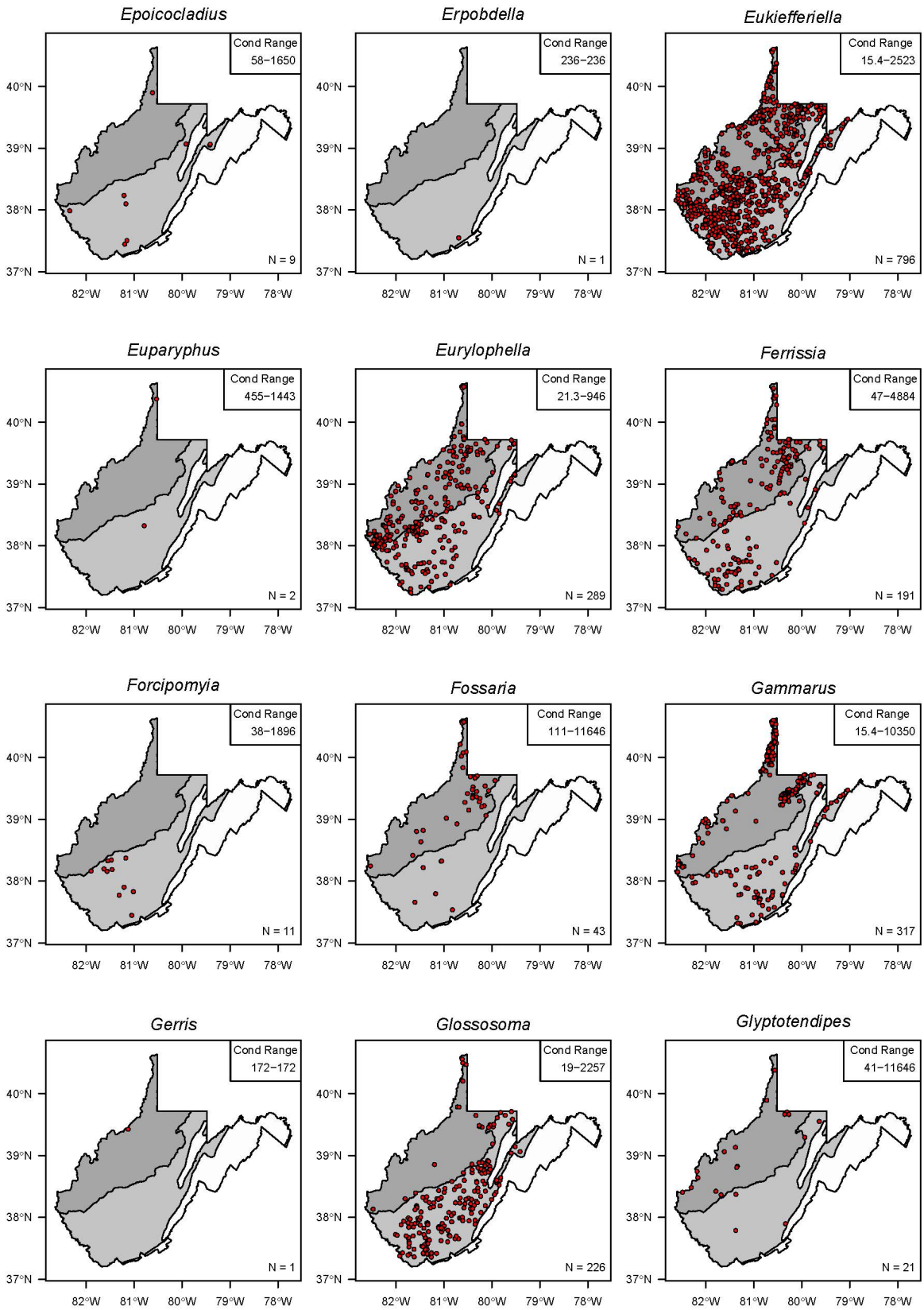

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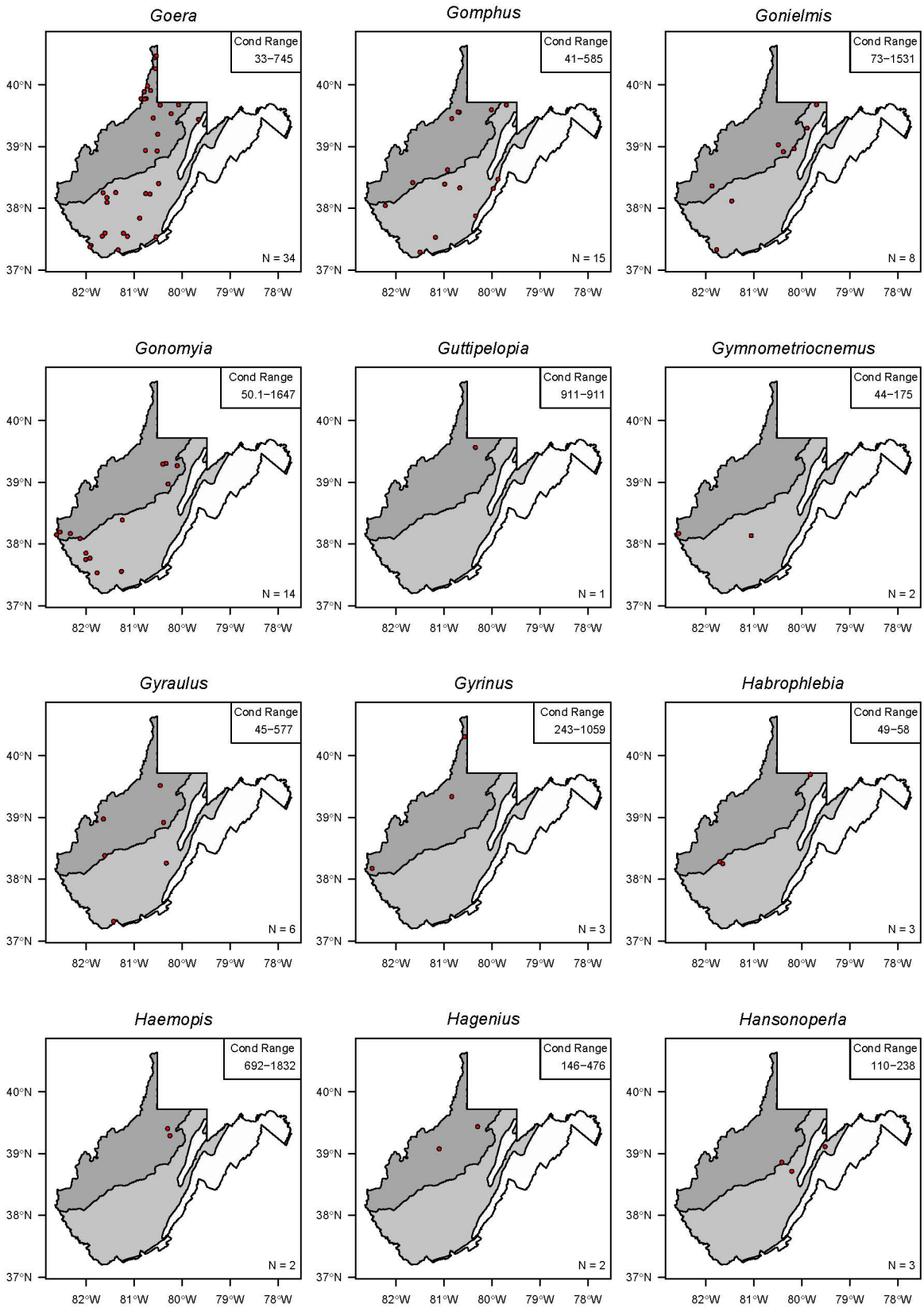

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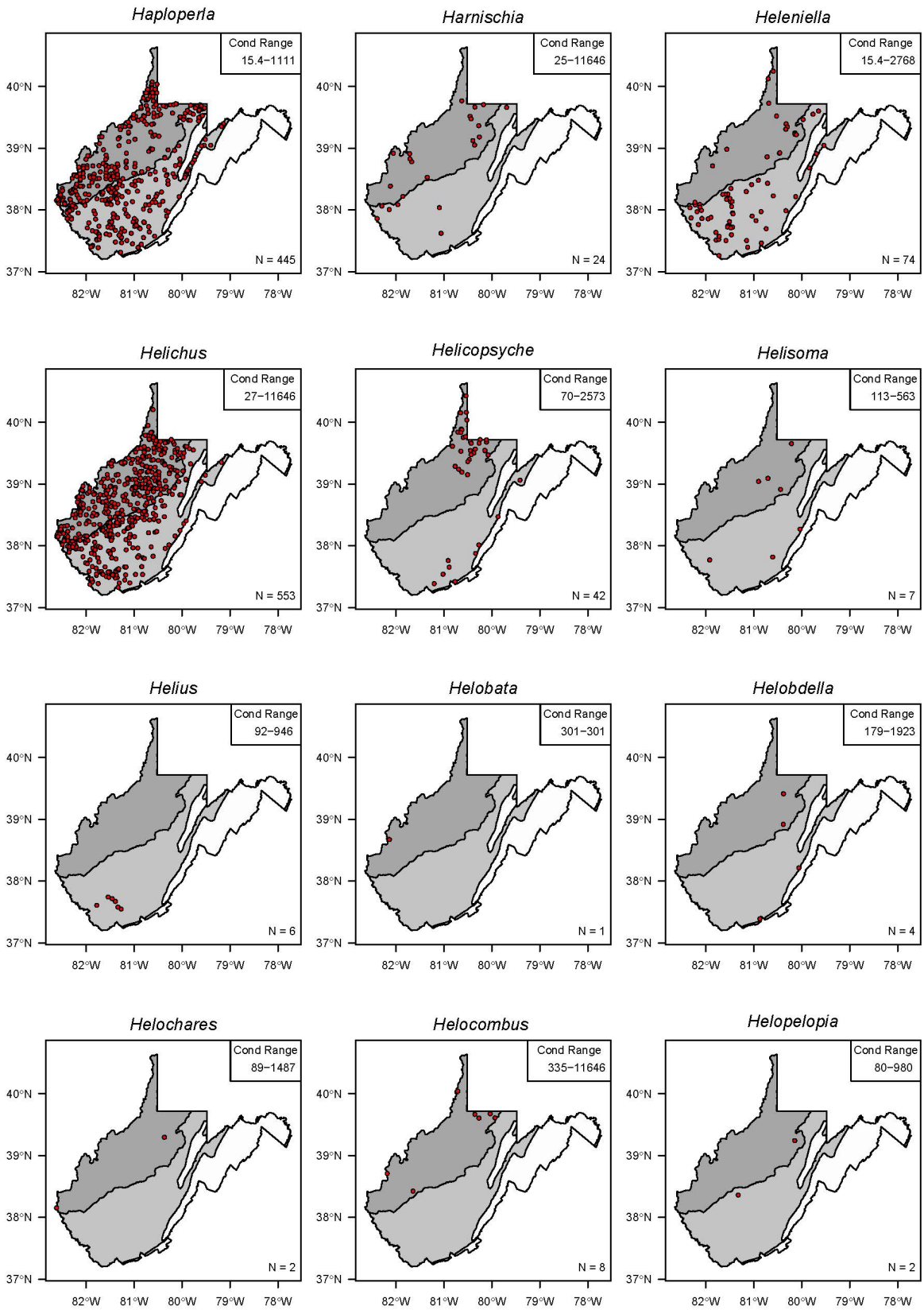

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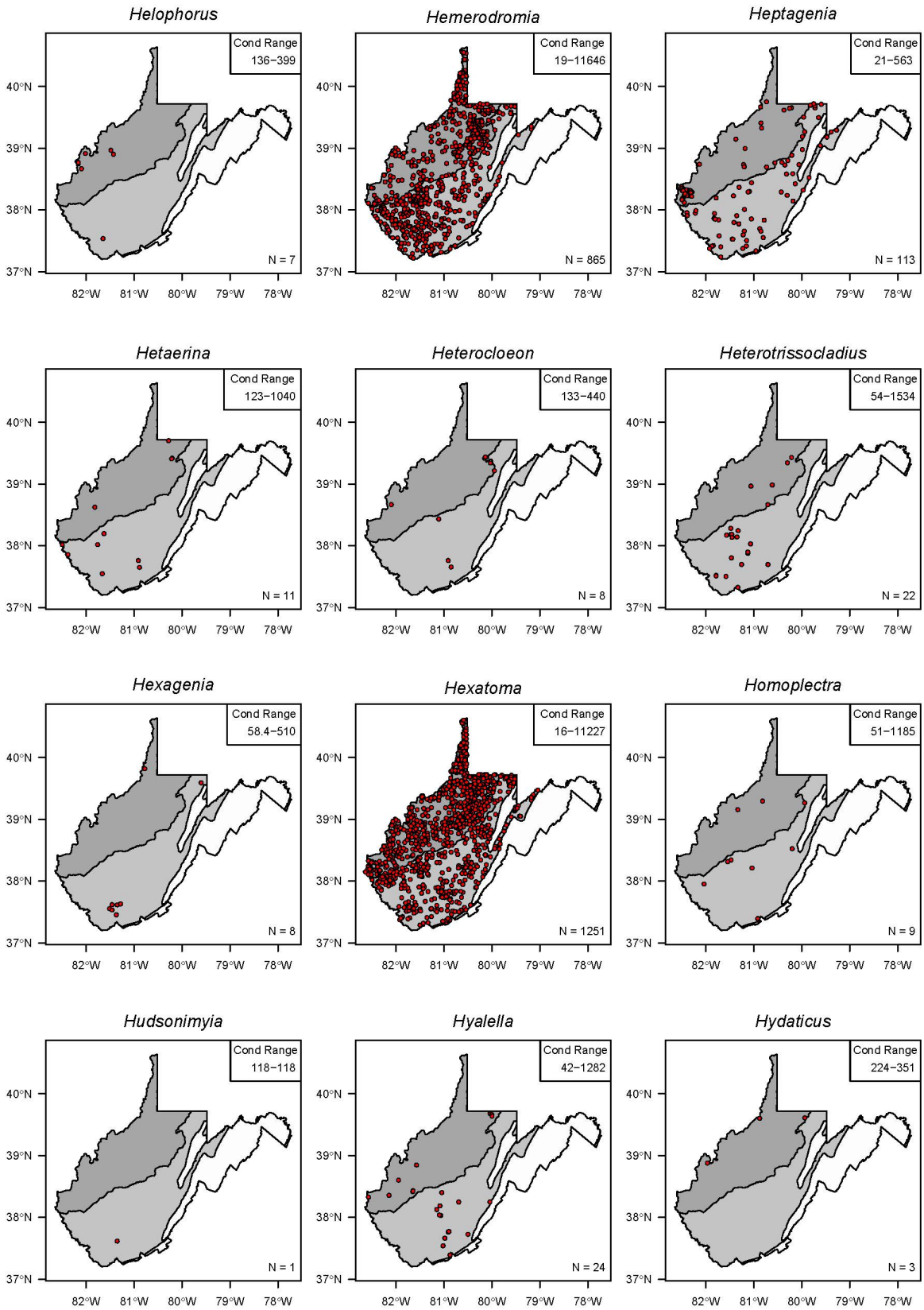

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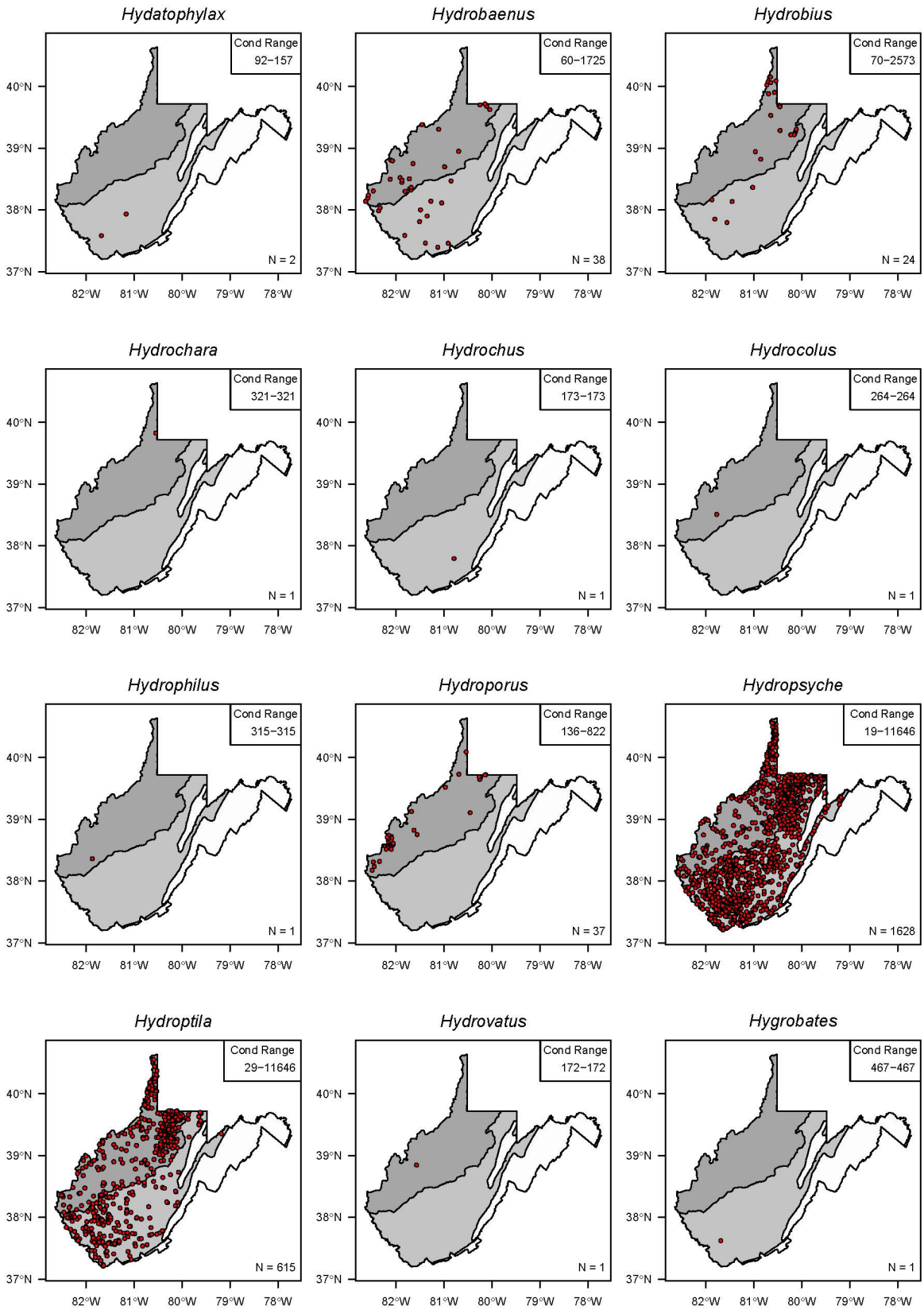

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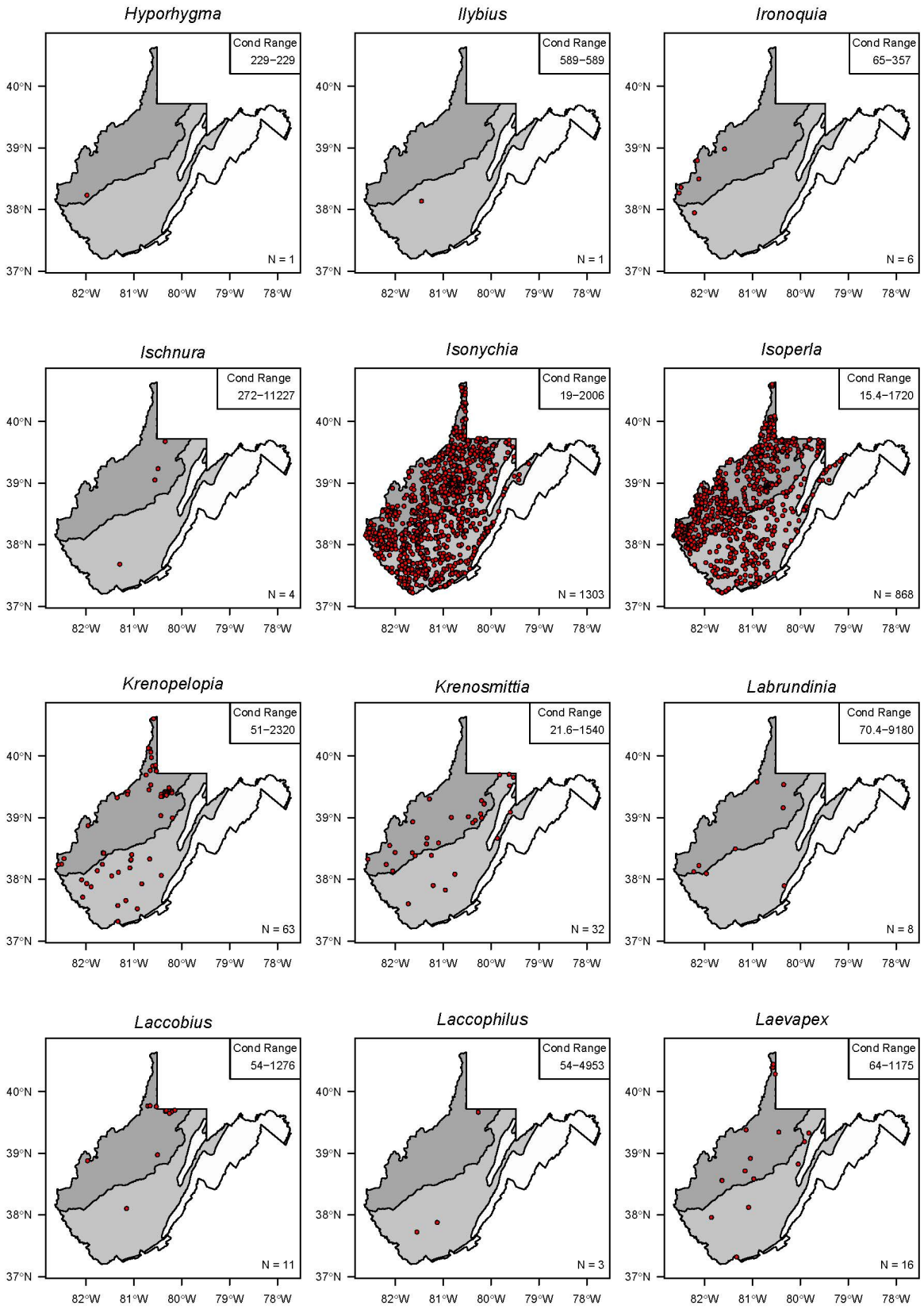

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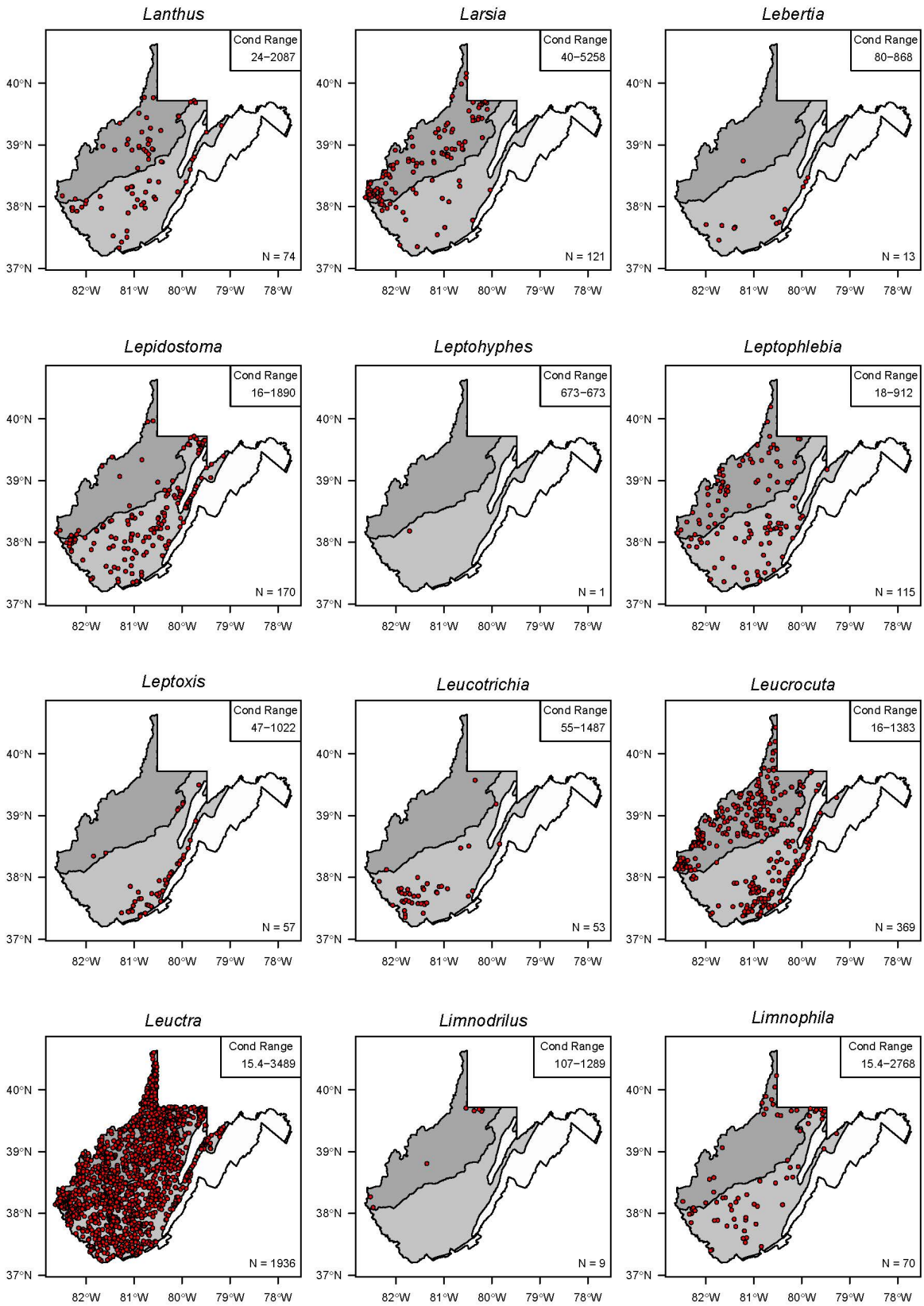

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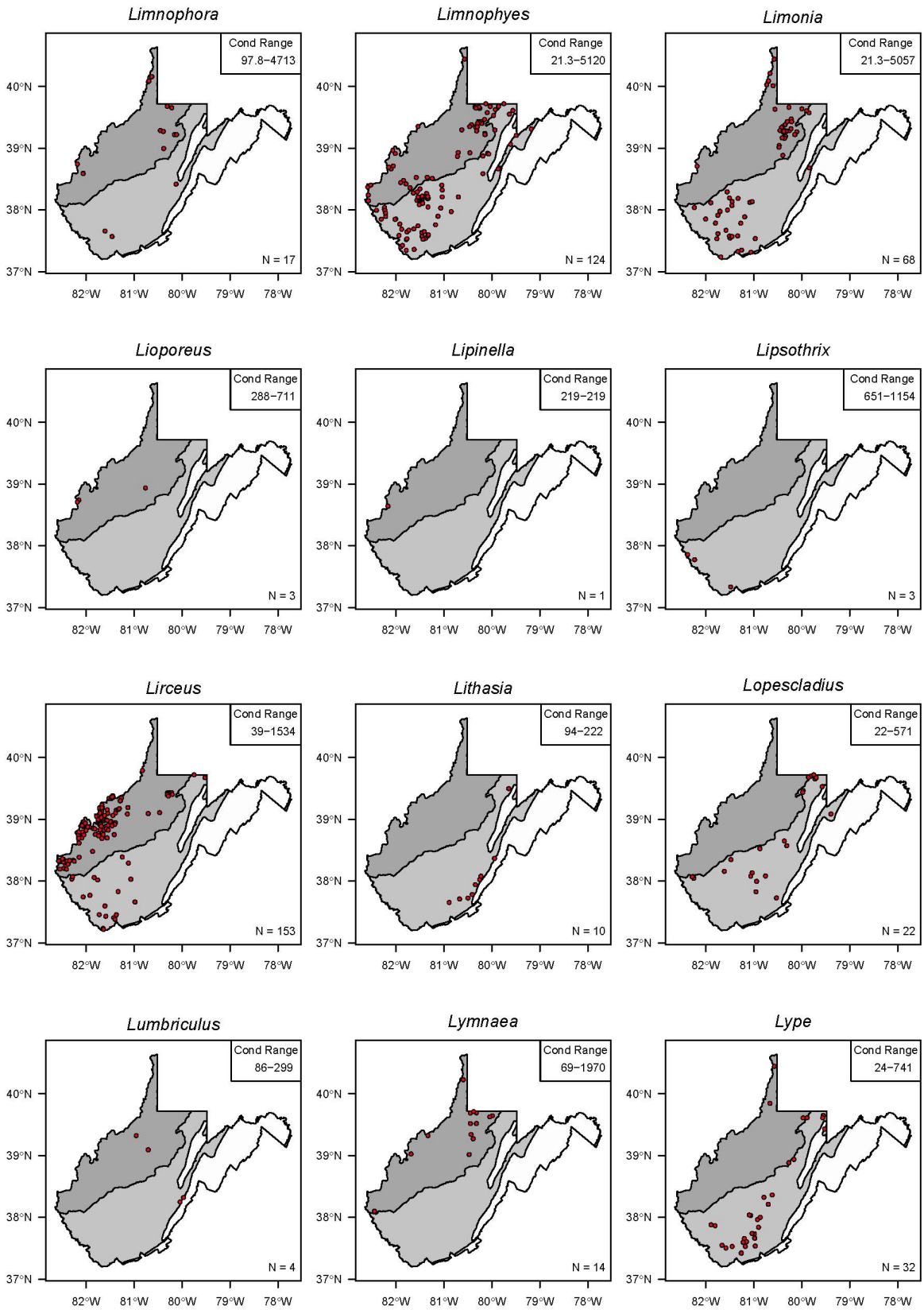

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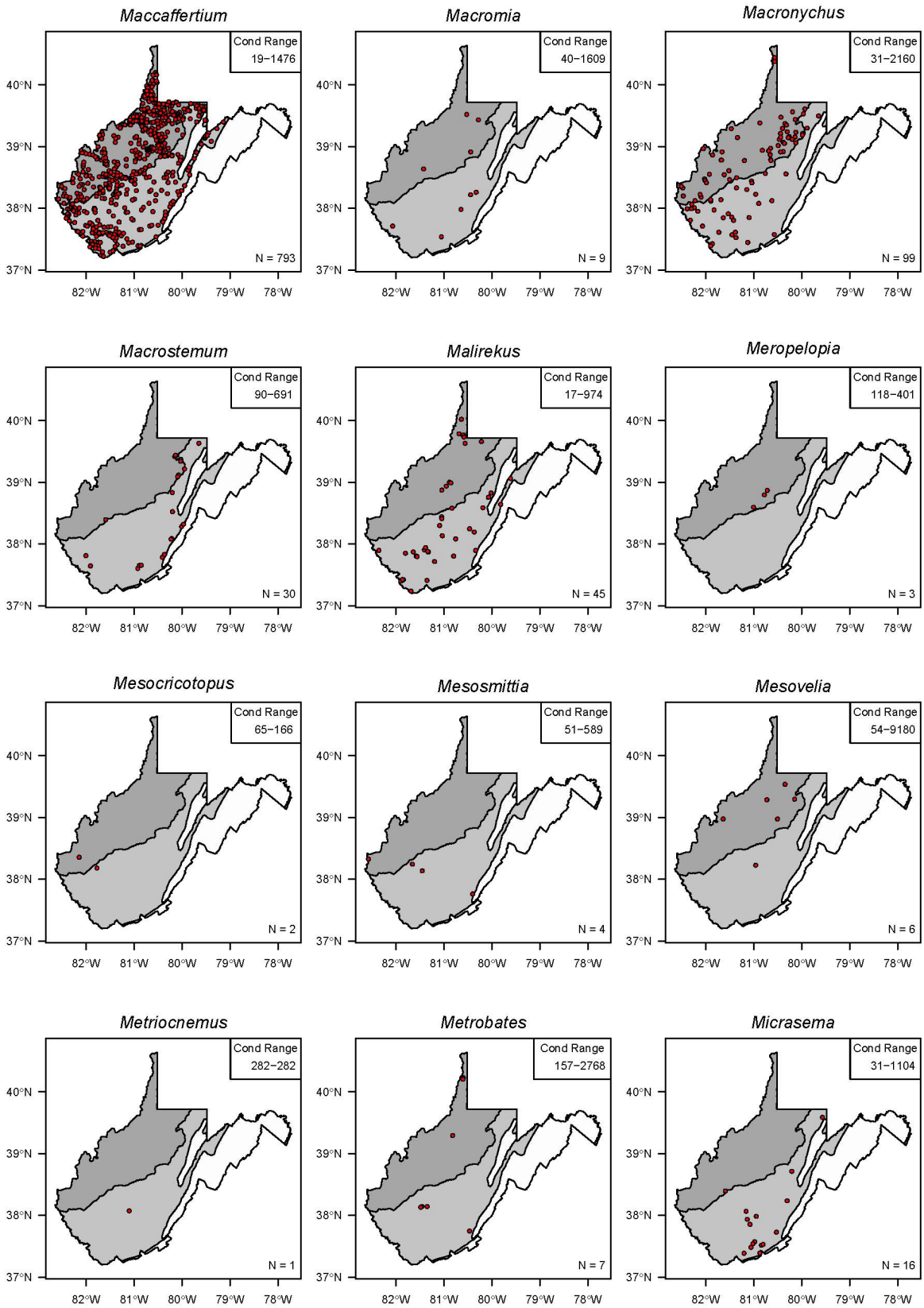

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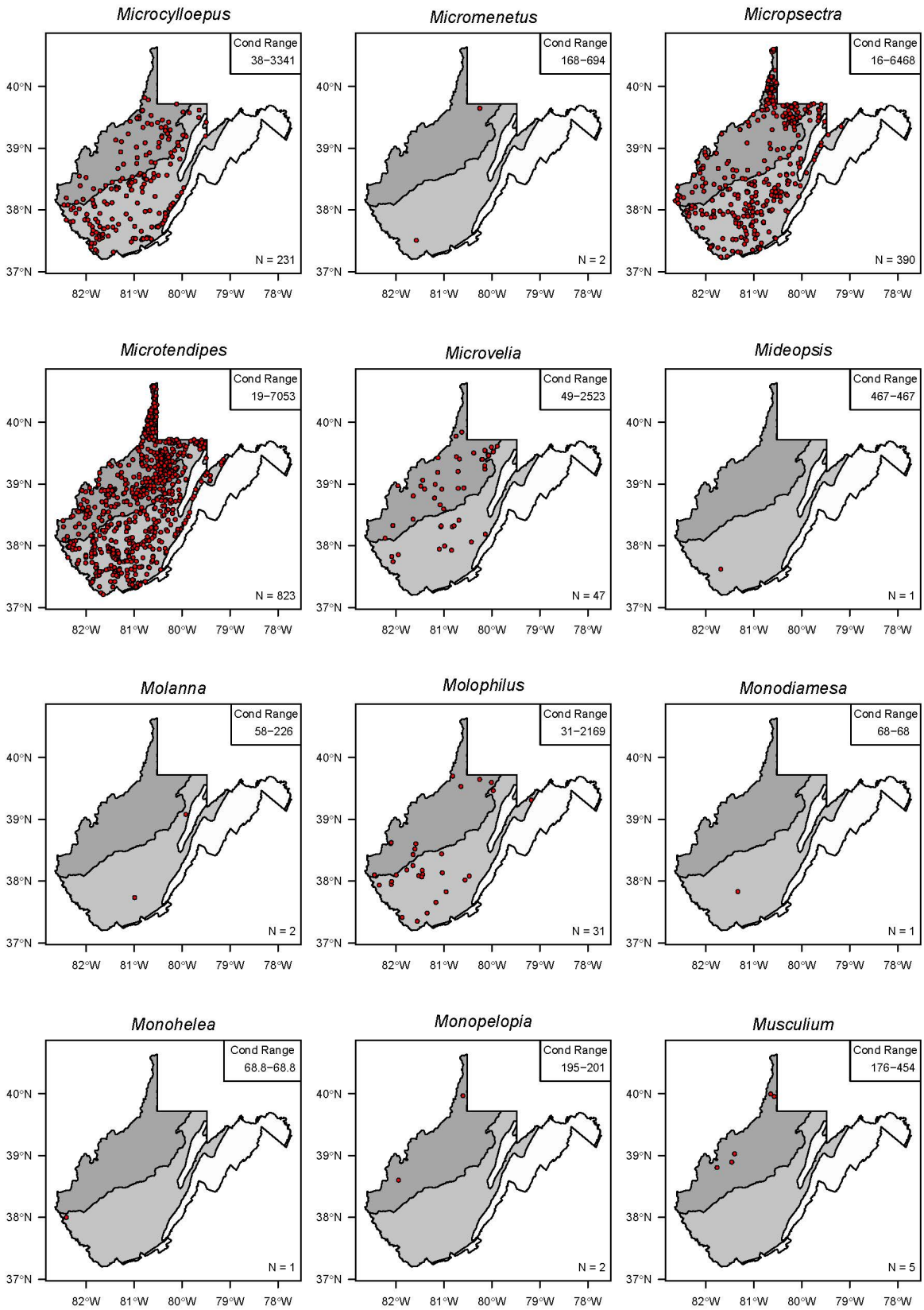

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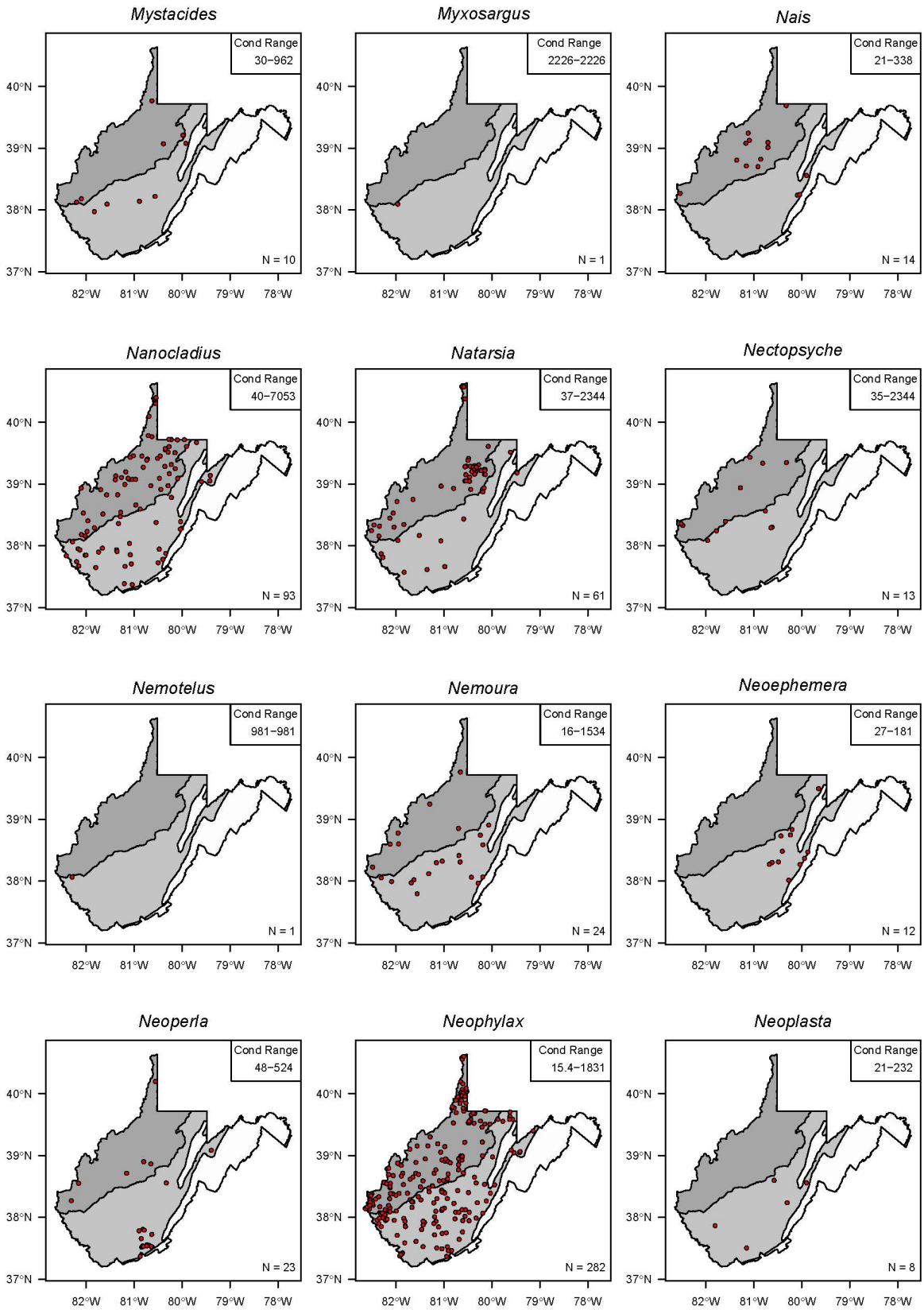

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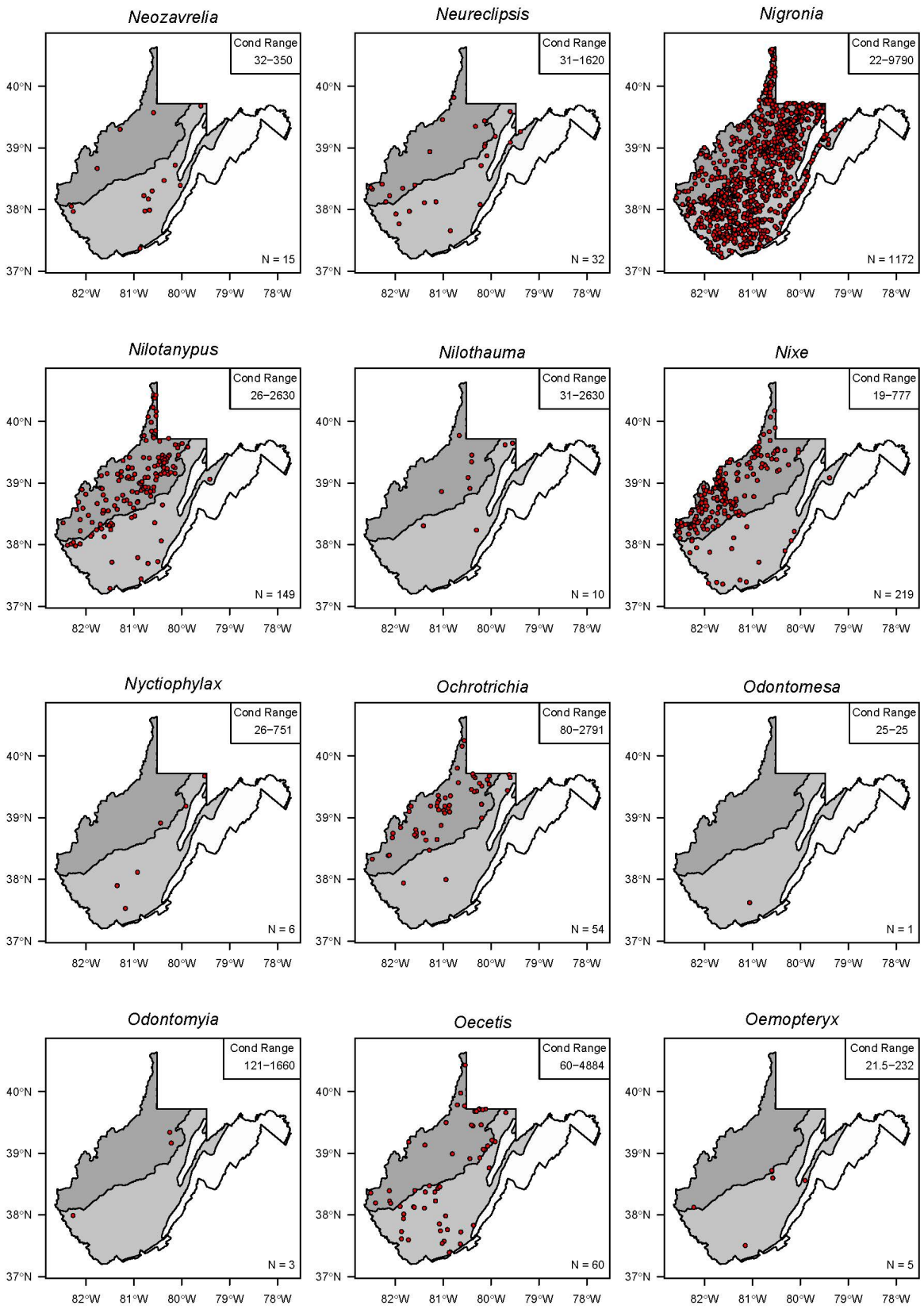

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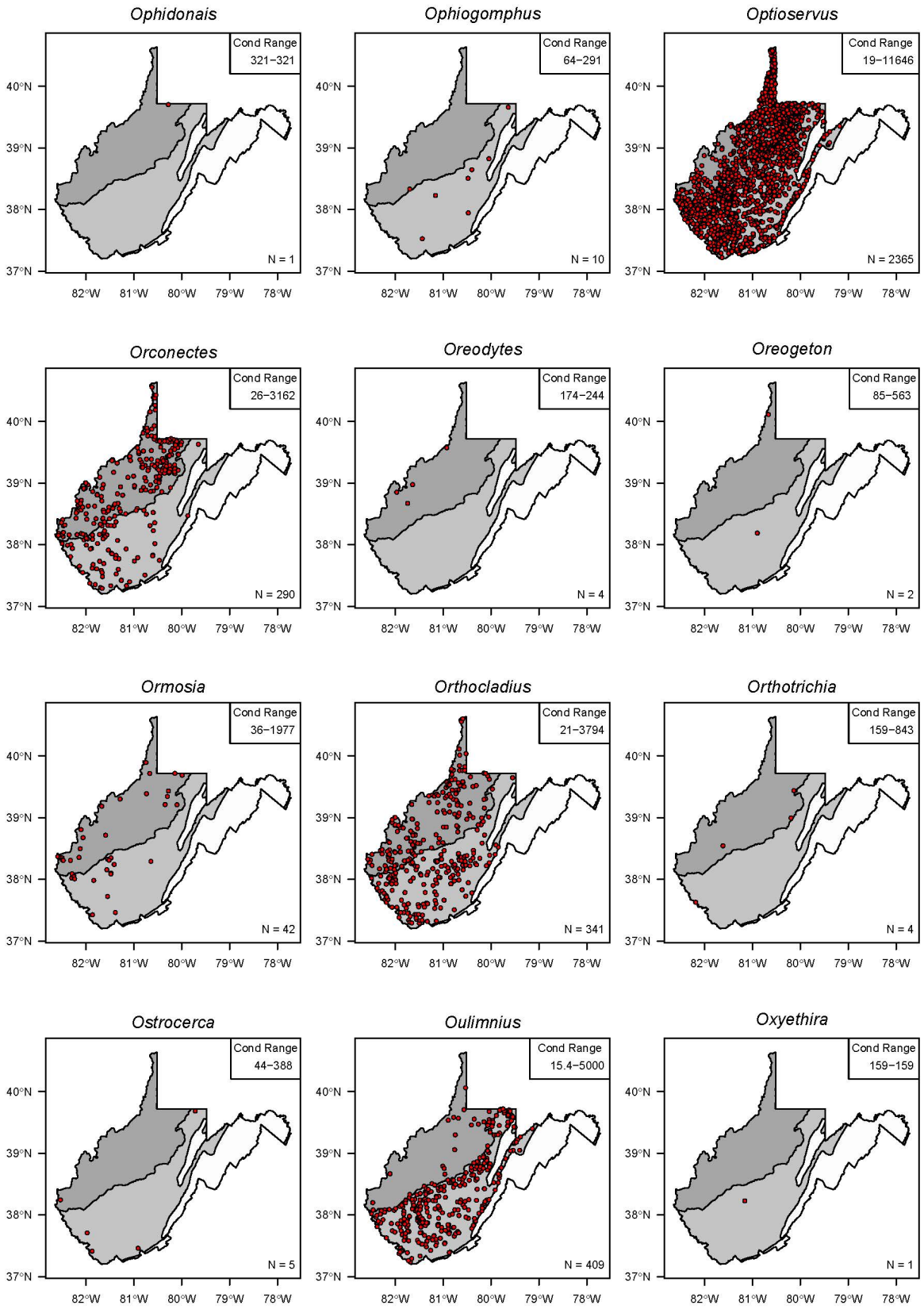

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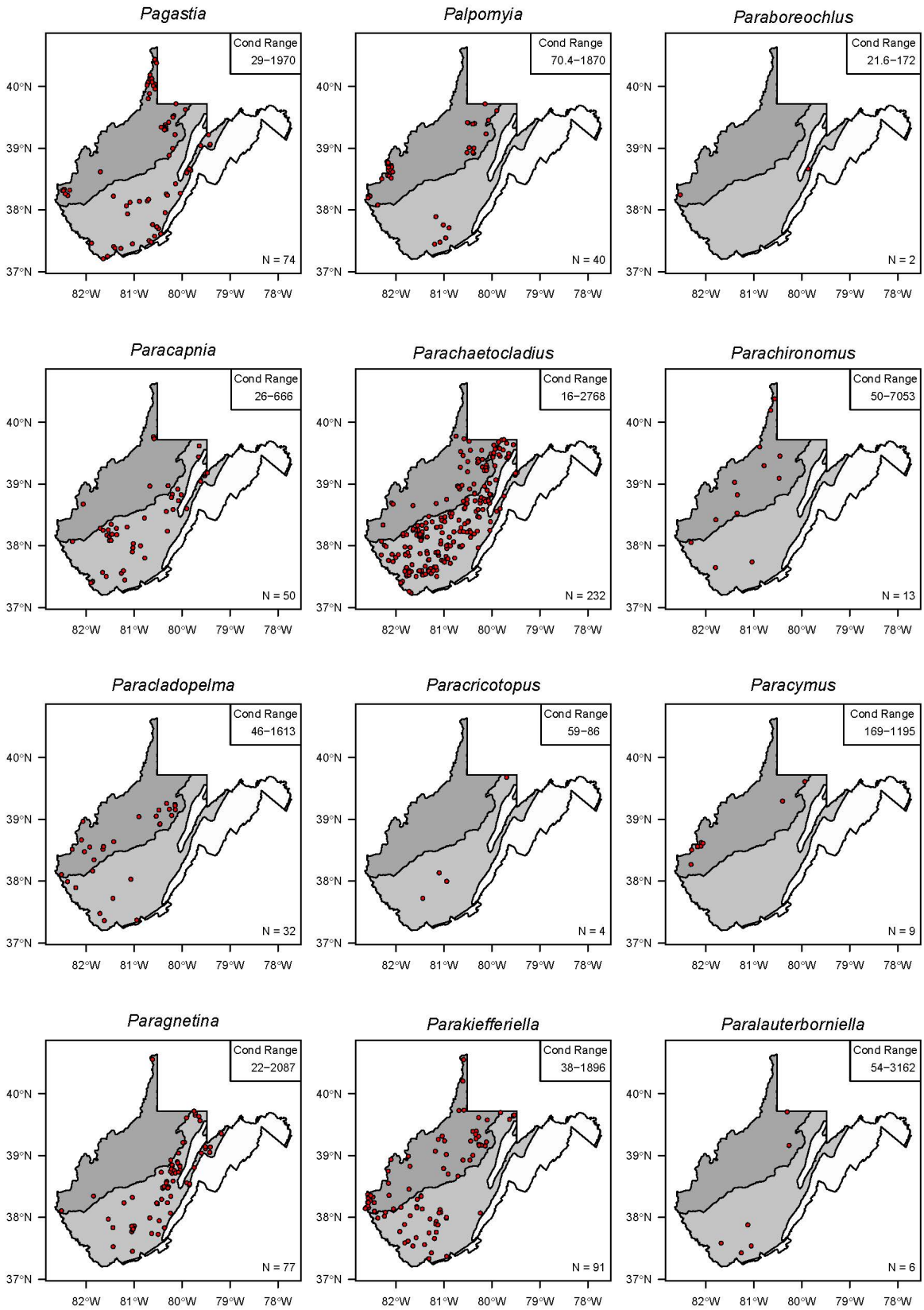

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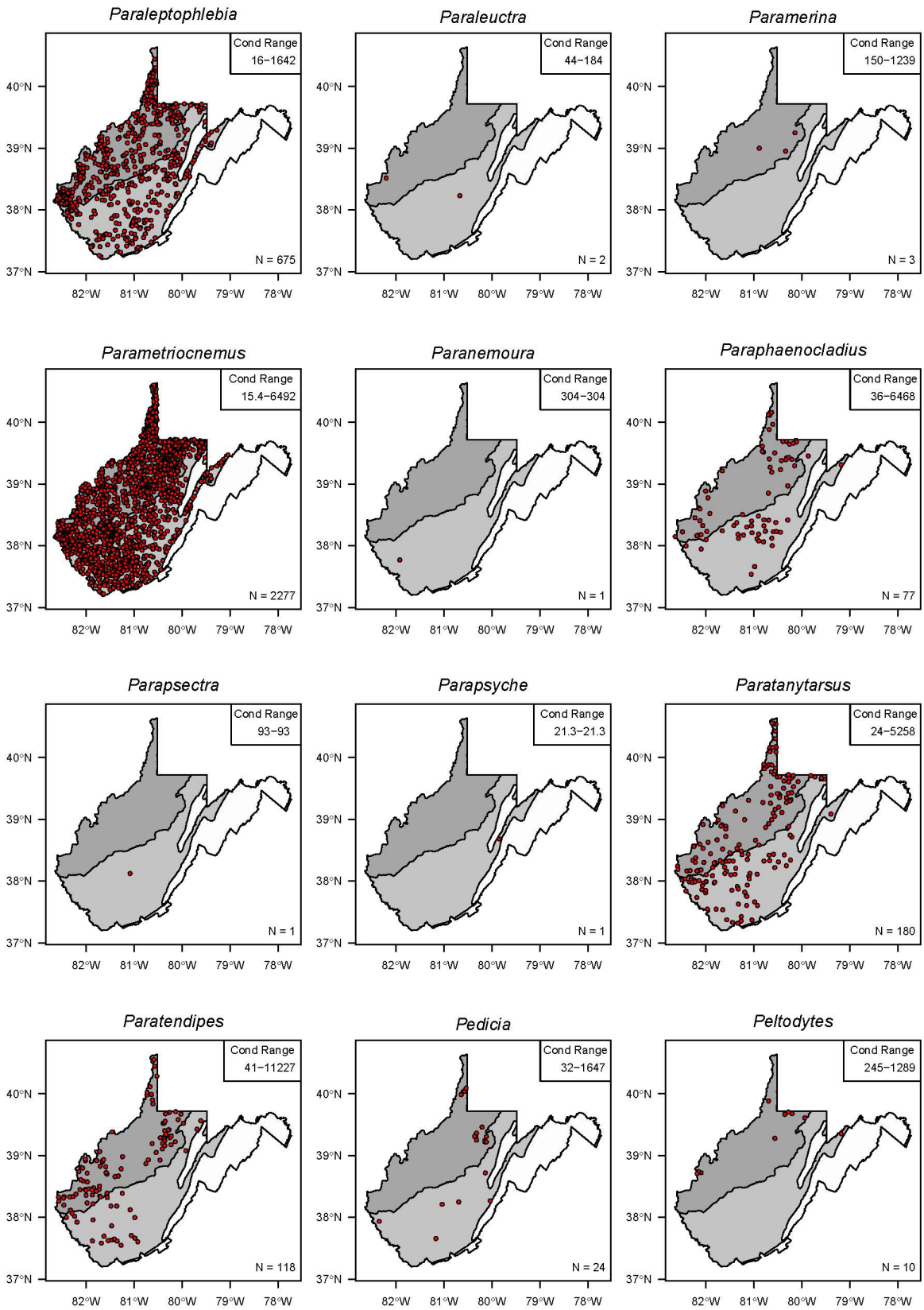

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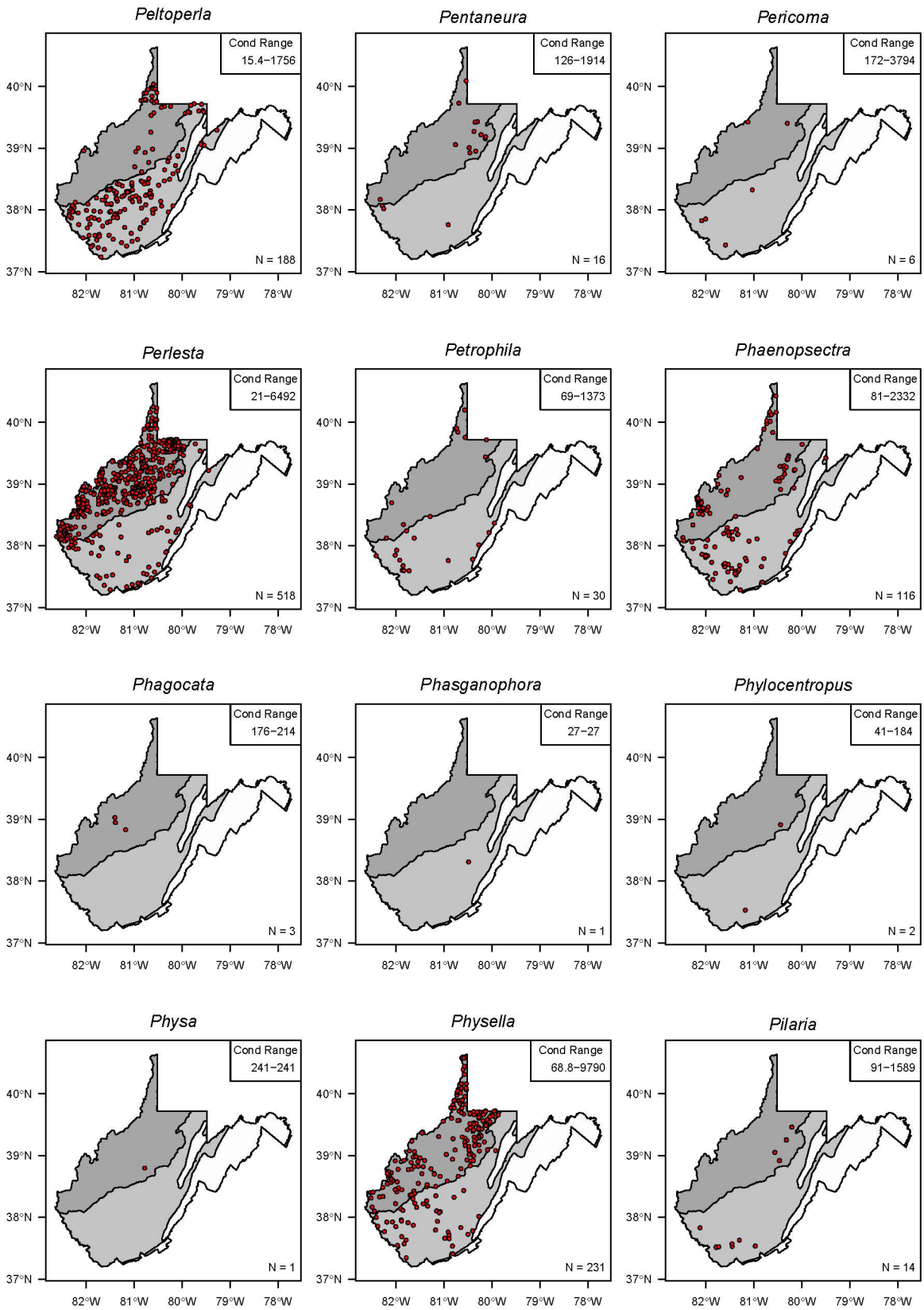

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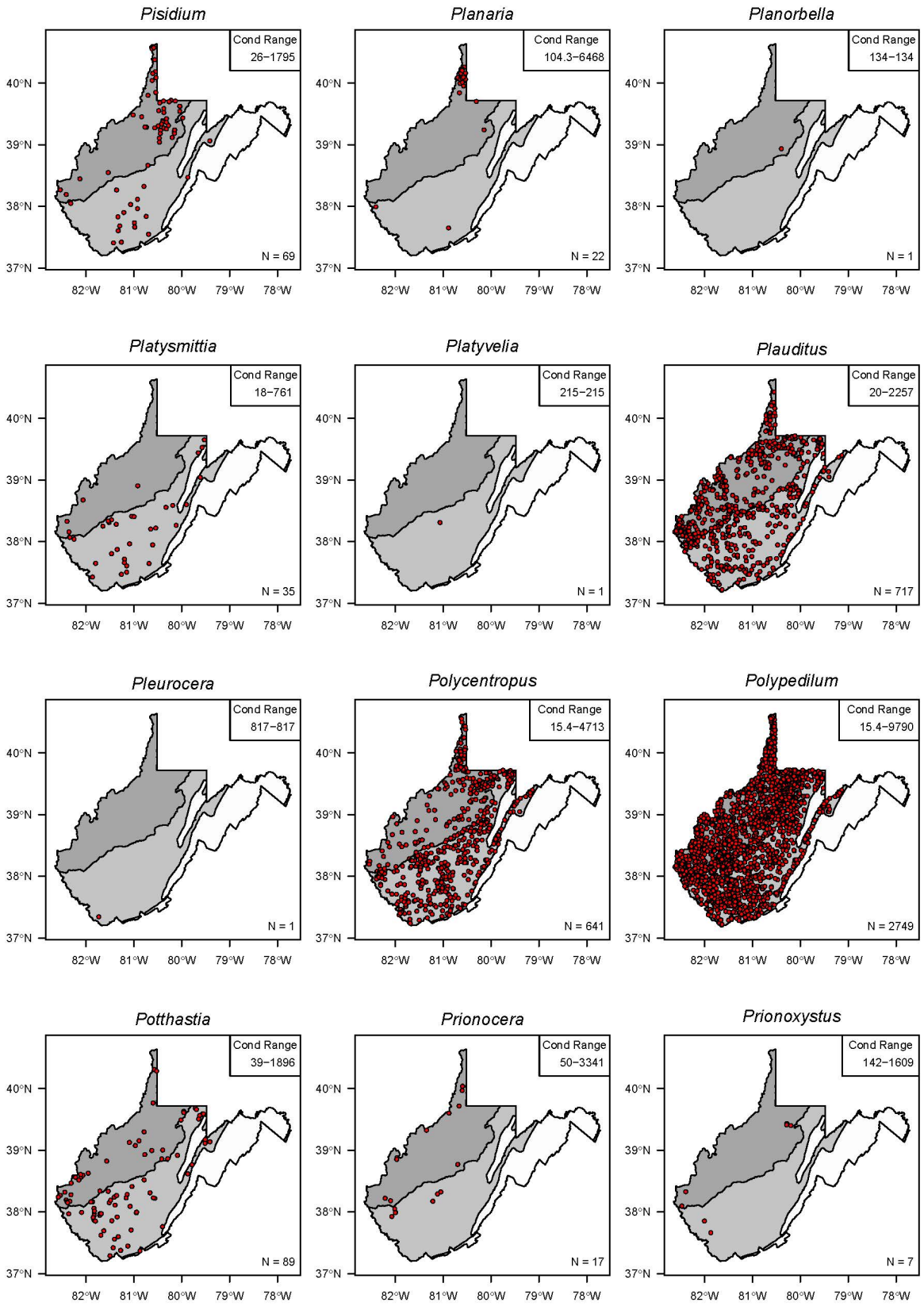

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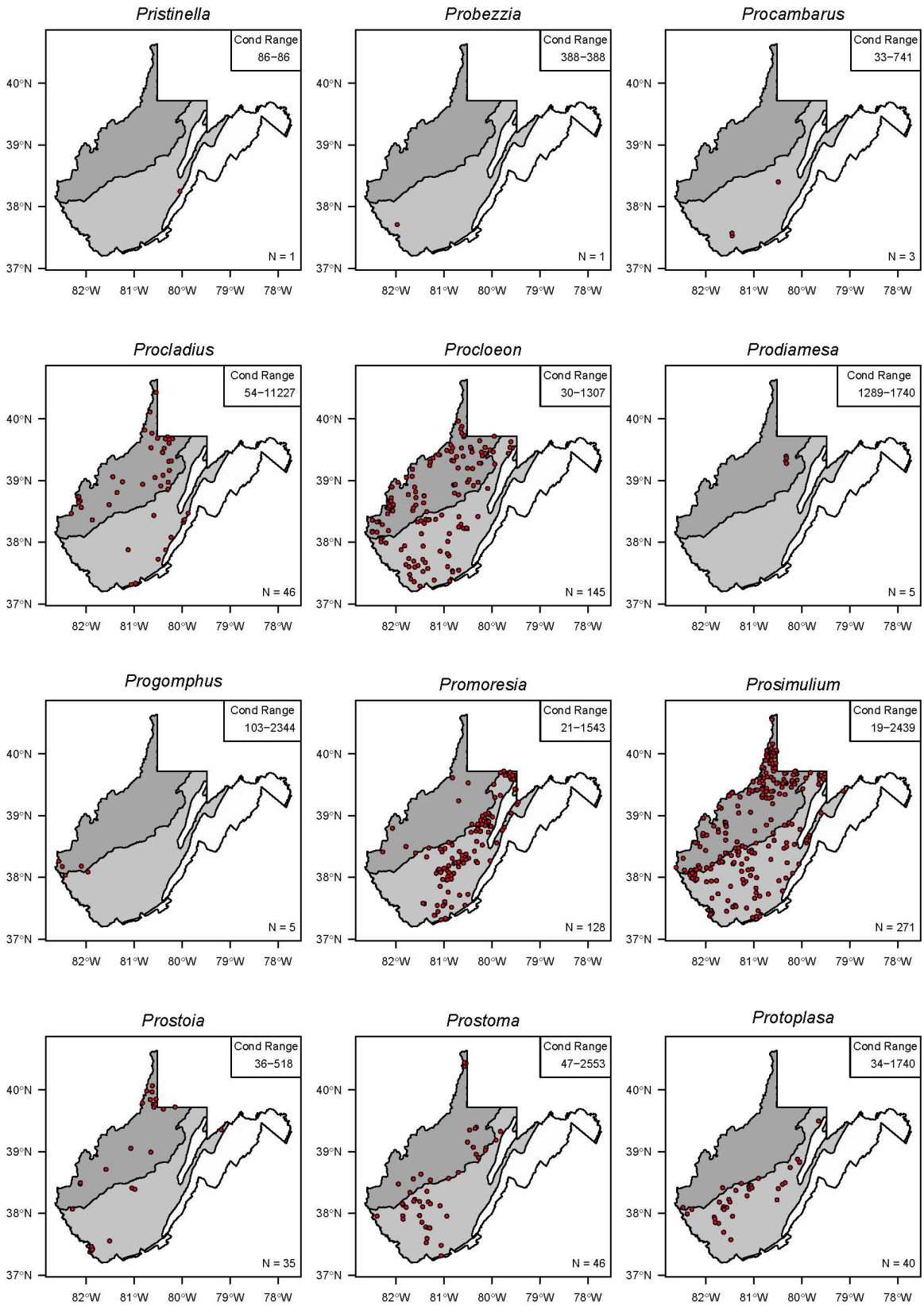

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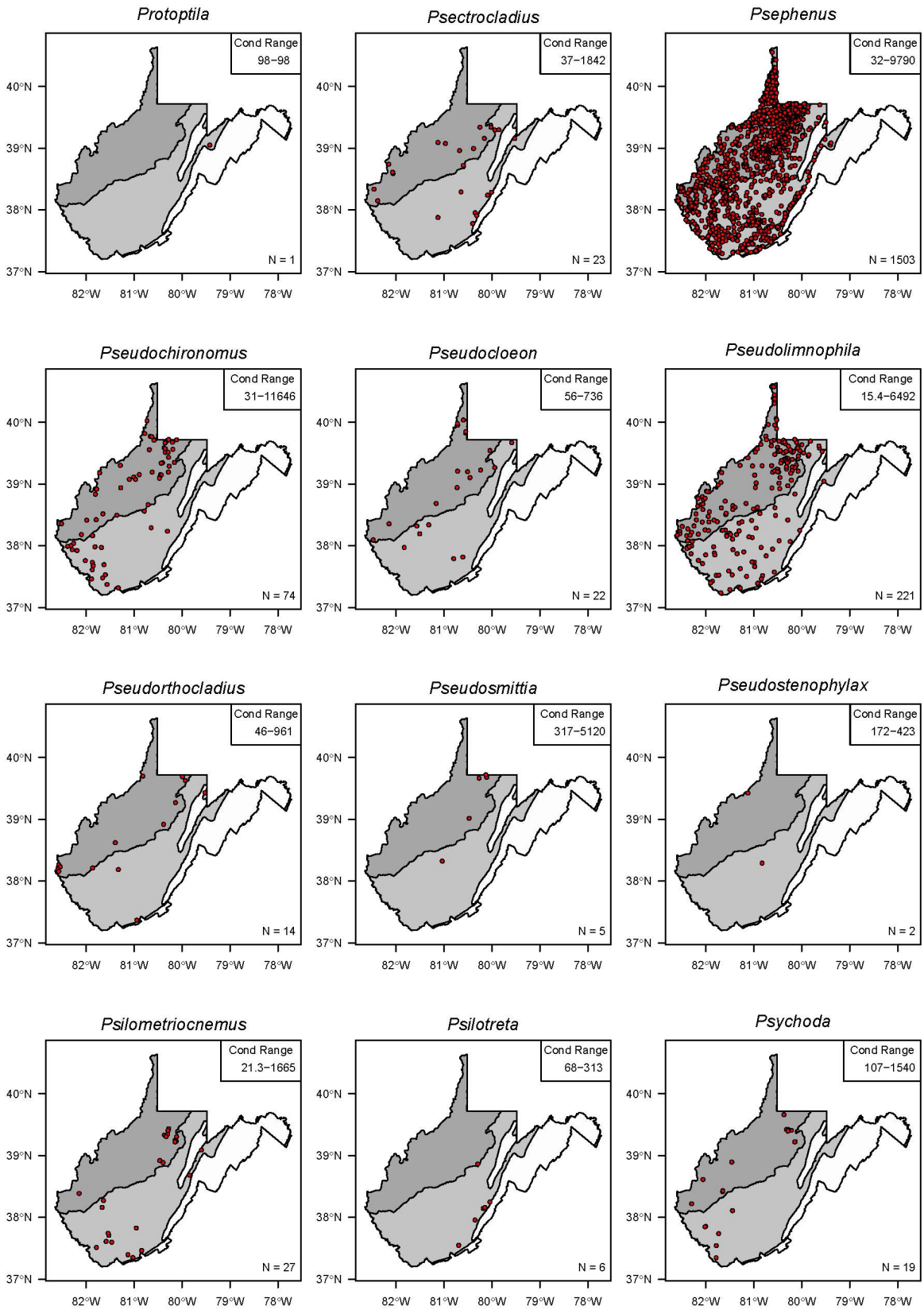

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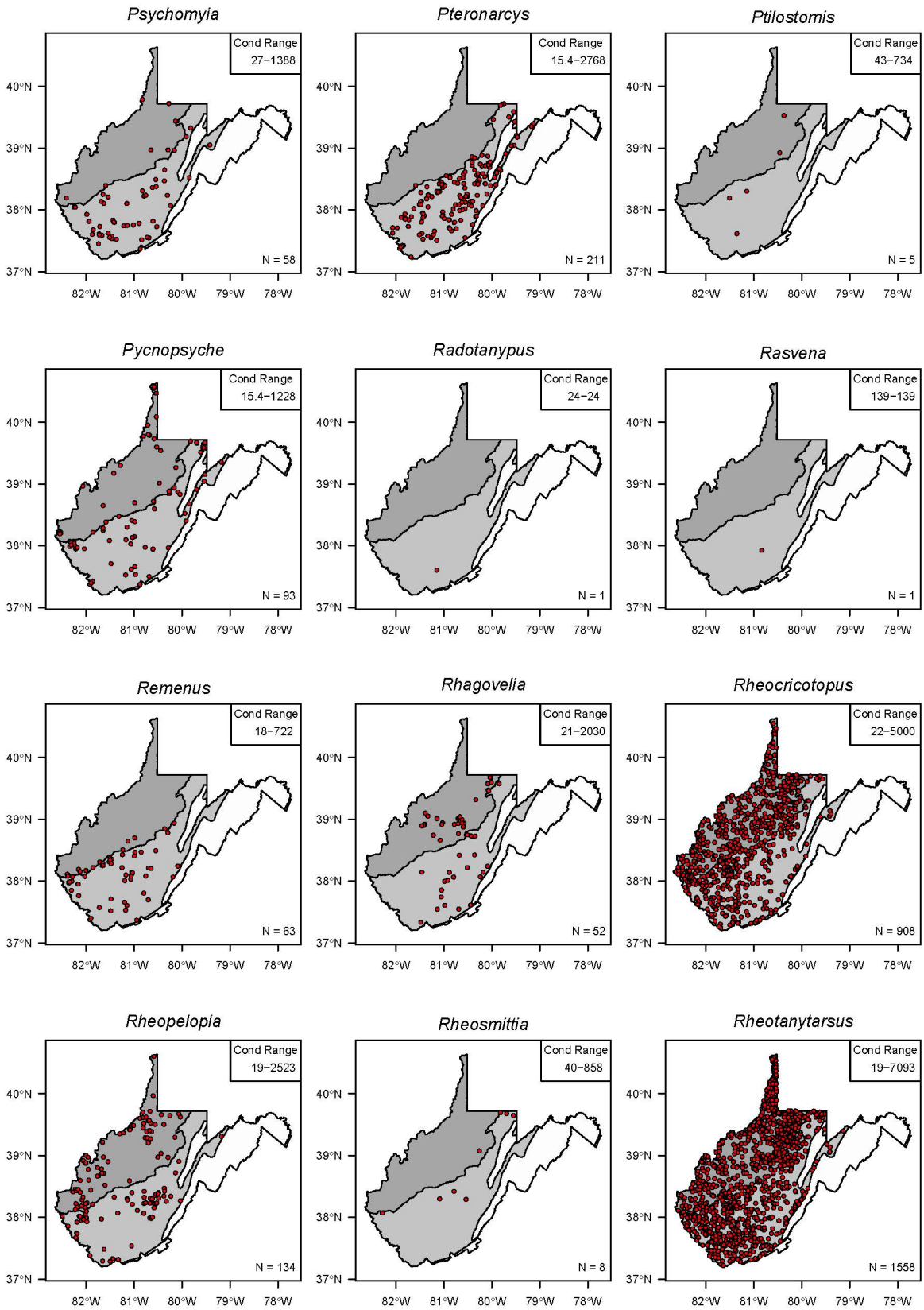

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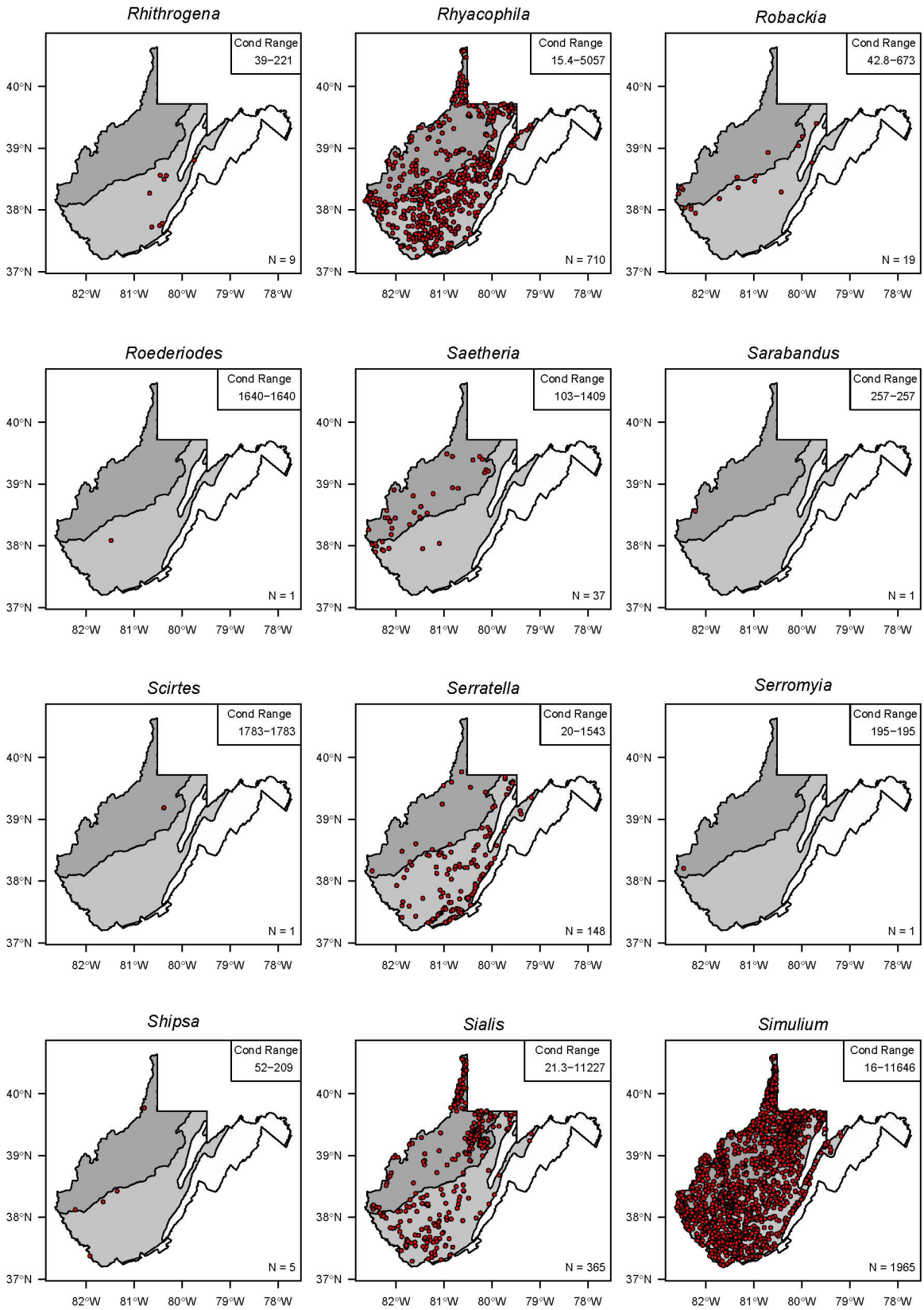

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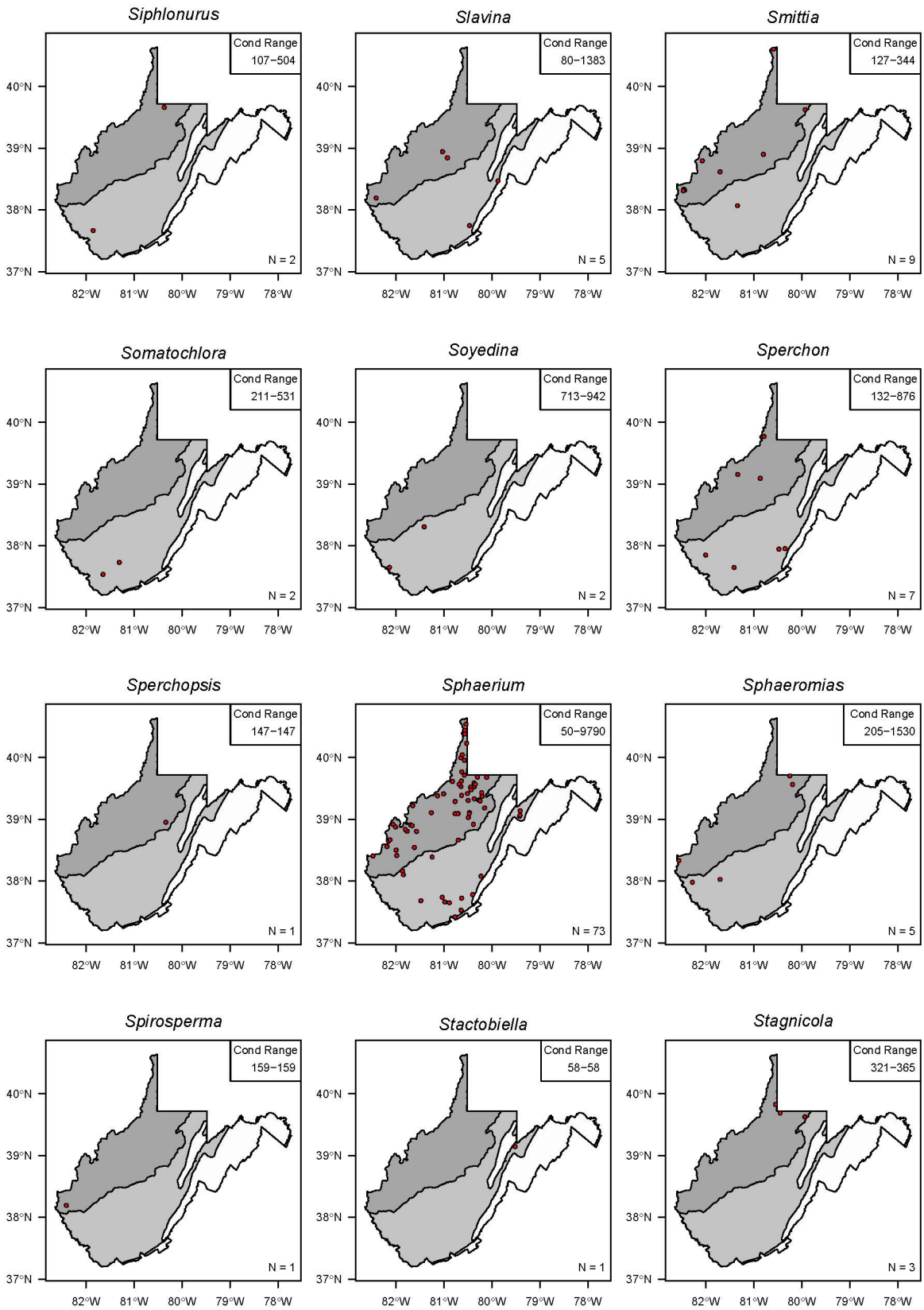

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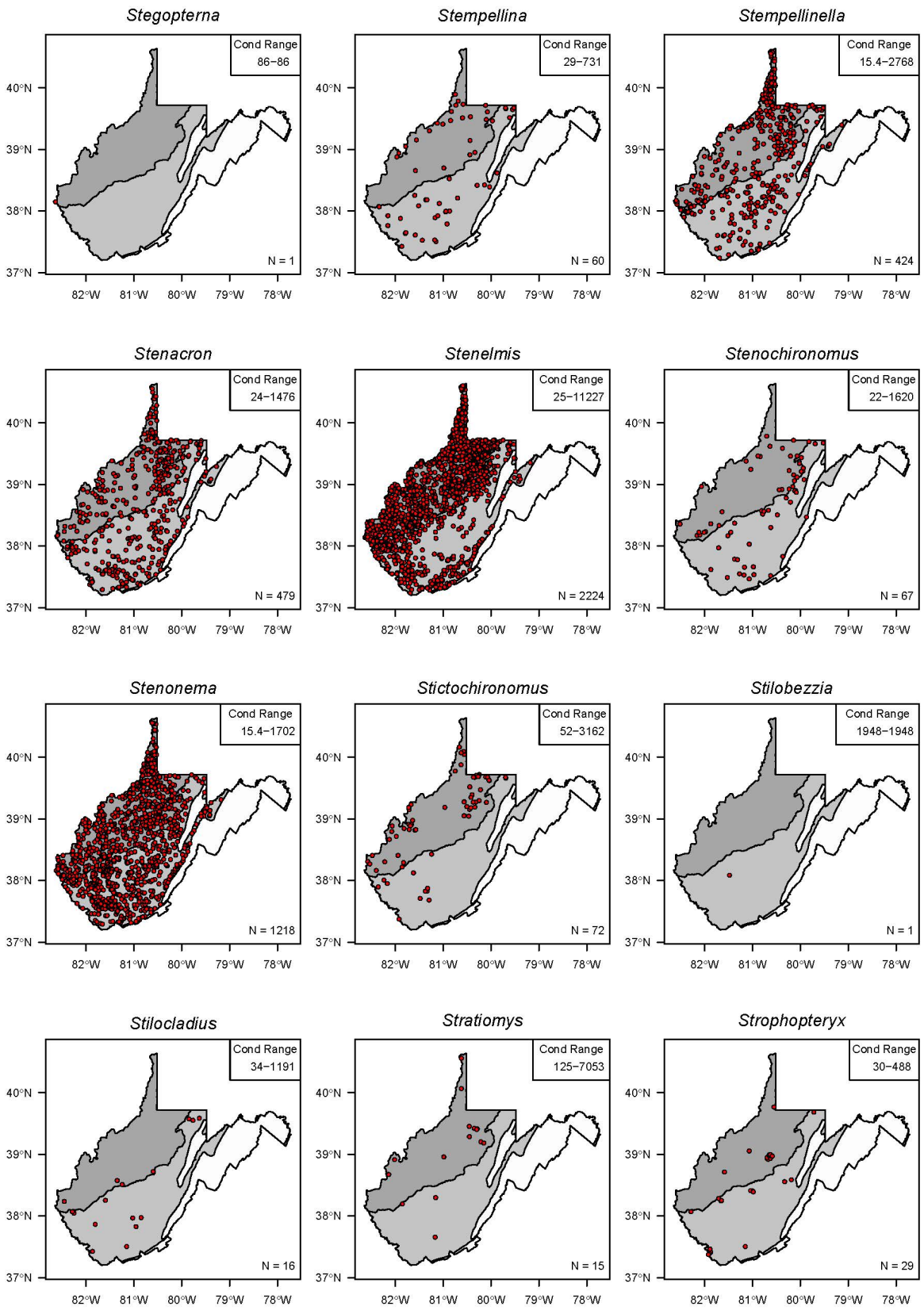

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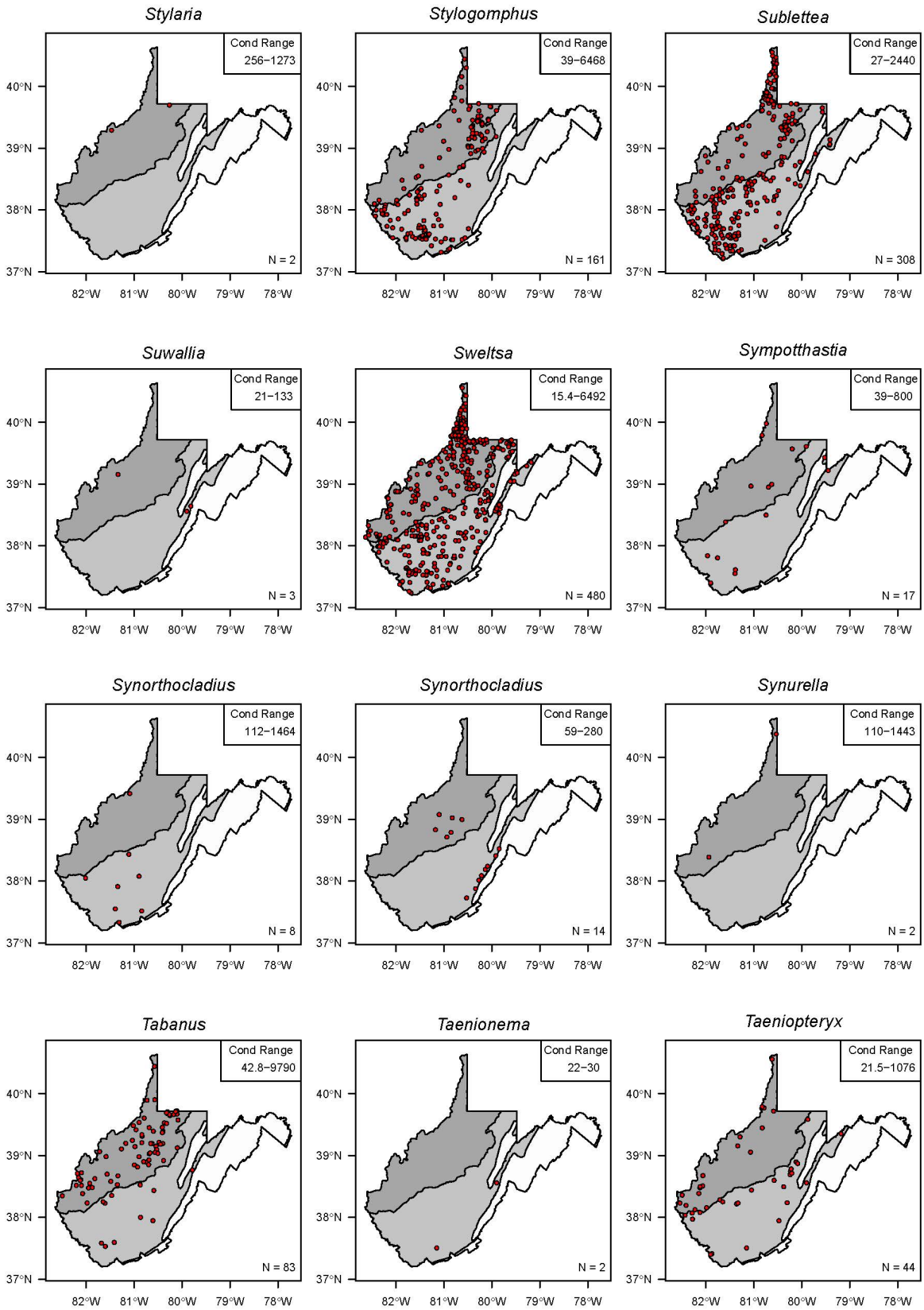

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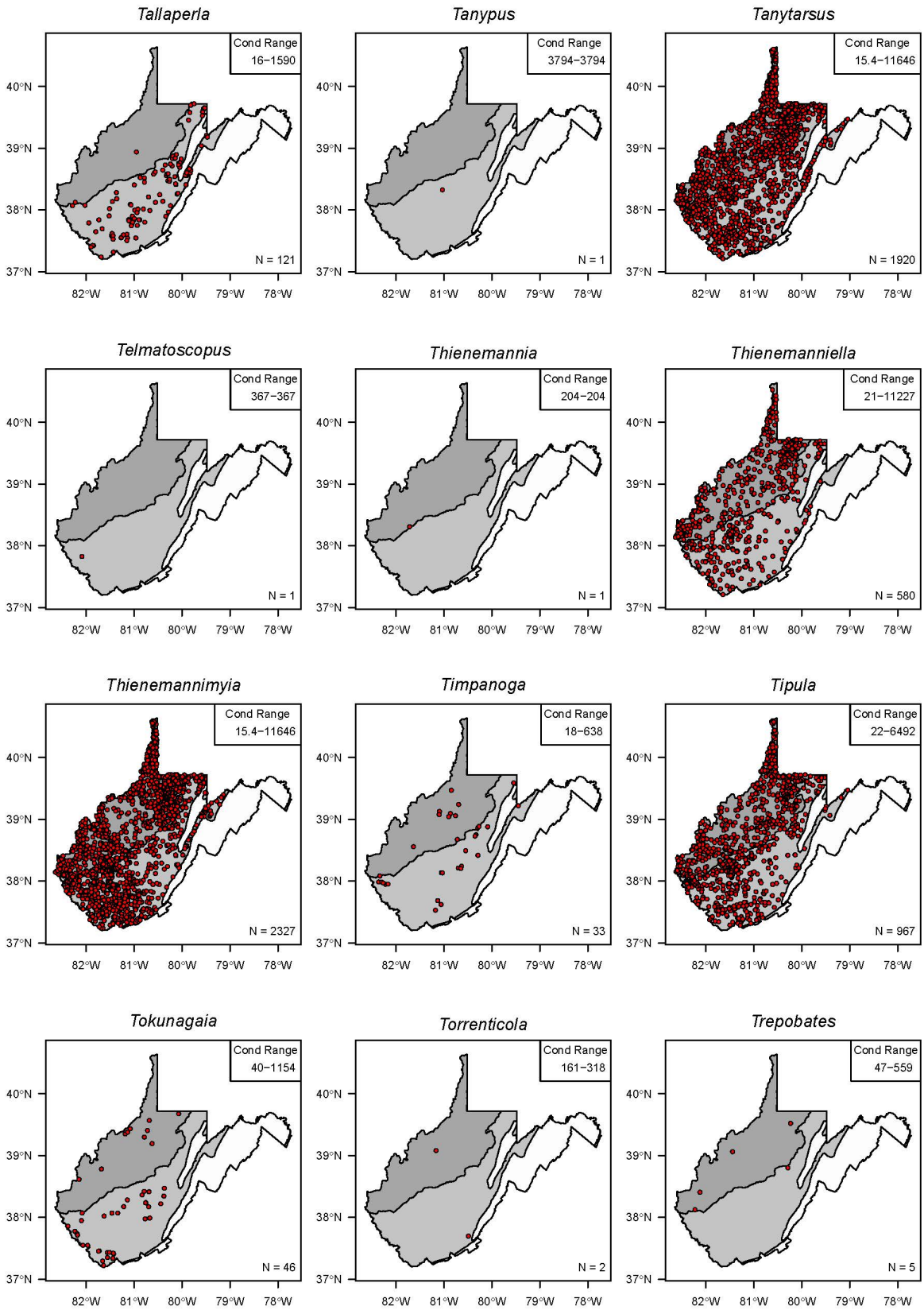

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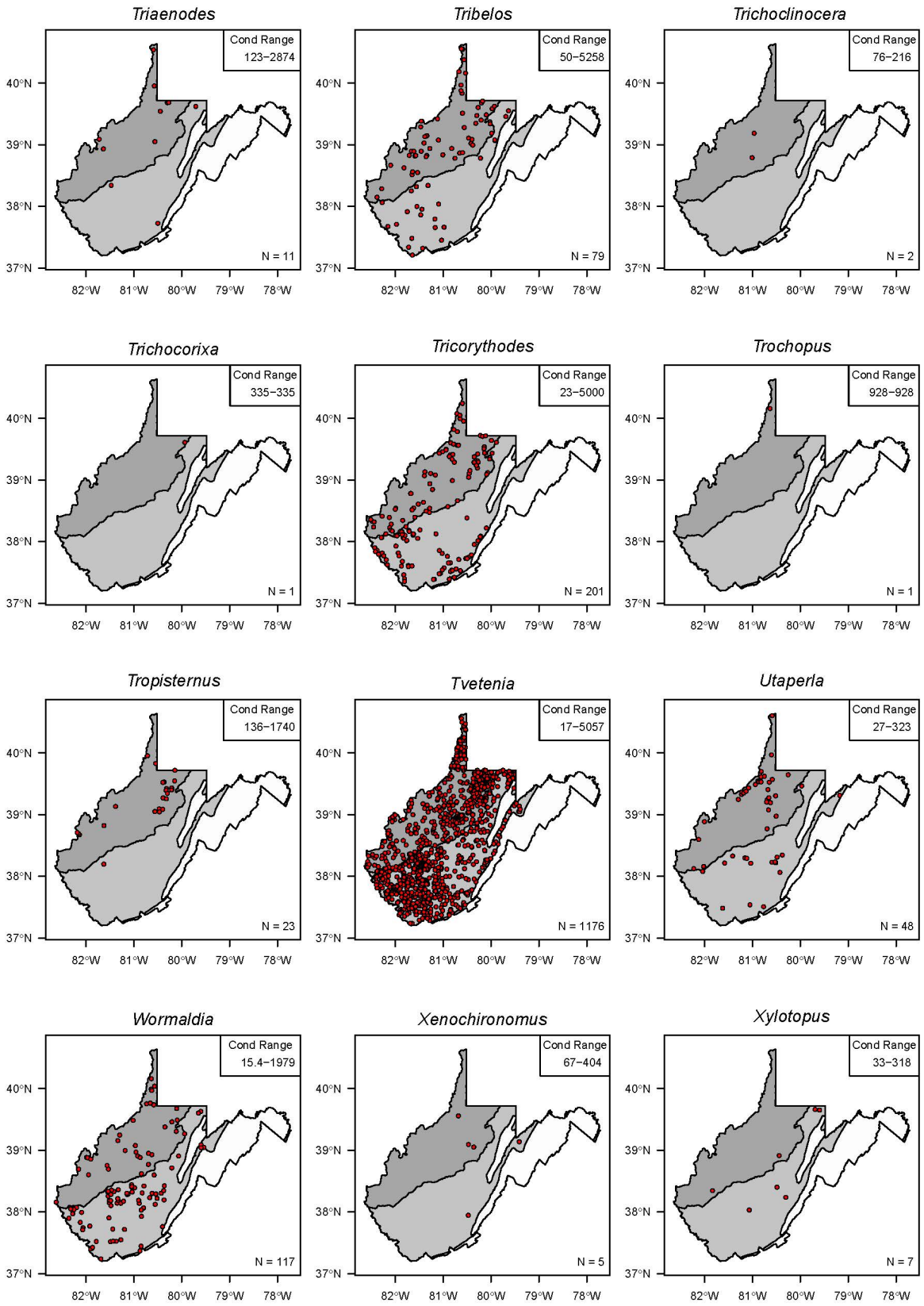

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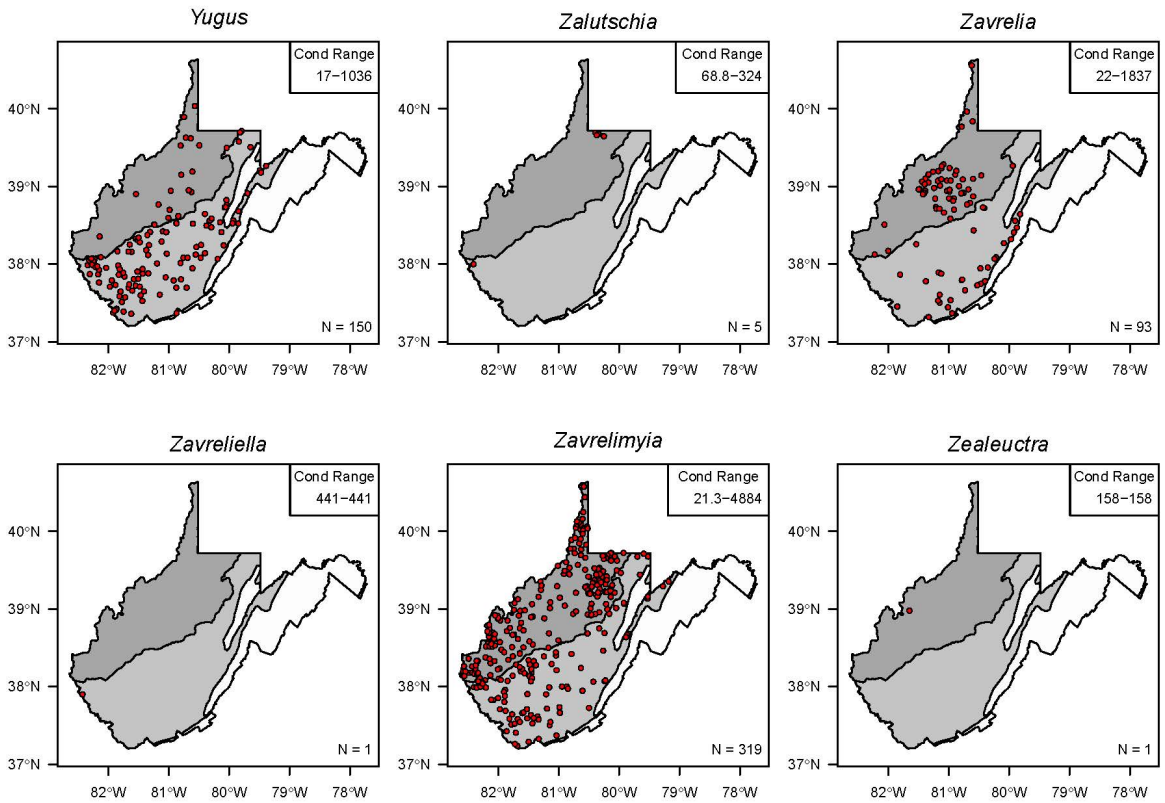

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