

Diversity Patterns of Pollinating Insect Communities in the Central Qinling Mountains and Their Responses to Environmental Change

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S1. Methods

S1.1 Diversity indices

Alpha diversity was quantified using species richness (S), Shannon diversity index (H'), total abundance (A), and Simpson dominance index (C).

Species richness (S) was defined as the total number of species within a sampling unit.

The Shannon diversity index (H'), which reflects community complexity, was calculated as:

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

where p_i represents the relative abundance of species i .

The Simpson dominance index (C), used to assess dominance and evenness within the community, was calculated as:

$$C = \sum_{i=1}^S (N_i/N)^2$$

where N is the total number of individuals and N_i is the abundance of species i .

Total abundance (A) was calculated as:

$$A_{total} = \sum_{i=1}^S N_i$$

and represents the total number of individuals, reflecting dominance structure and community responses to environmental variation.

S1.2 Jaccard similarity index

Community similarity was evaluated using the Jaccard similarity index:

$$C_j = \frac{C}{(A + B - C)}$$

where C is the number of shared species between two communities, and A and B are the total number of species in communities a and b , respectively. The similarity categories were defined as follows: 0 (completely dissimilar), 0.01–0.25 (extremely dissimilar), 0.26–0.50 (slightly similar), 0.51–0.75 (moderately similar), 0.76–0.99 (highly similar), and 1 (identical) (Jaccard, 1908).

S1.3 Driving mechanism analysis models

(1) Main effects model

To evaluate the overall effects of environmental variables on diversity metrics, the following model was used:

$$Y_i = \beta_0 + \sum_{k=1}^p \beta_k X_{ki} + \varepsilon_i$$

where i represents the sampling site ($i = 1, \dots, N$), Y_i is the response variable (Richness, Shannon diversity, or Abundance), β_0 is the intercept, β_k represents the regression coefficient for the k -th environmental variable, X_{ki} is the value of the k -th environmental variable at site i (e.g., MAT, MAP, elevation, Cro_prop), and ε_i is the residual error term (assumed to follow a normal distribution in LM: $\varepsilon_i \sim N(0, \sigma^2)$).

(2) Habitat interaction model

To test whether environmental effects differ among habitat types, an interaction model between environmental variables and habitat was constructed:

$$Y_i = \beta_0 + \sum_{k=1}^p \beta_k X_{k,i} + \sum_{h=1}^p \gamma_h H_{h,i} + \sum_{k=1}^p \sum_{h=1}^p \delta_{kh} (X_{k,i} H_{h,i}) + \varepsilon_i$$

where H_{hi} represents the dummy variable for habitat type (agricultural, seminatural, natural), γ_h is the main effect of habitat, and δ_{kh} represents the interaction effect between environmental variables and habitat.

(3) Environmental interaction model

To examine interactions between environmental variables, a pairwise interaction analysis was conducted using a binary grouping strategy. For each grouping variable G , a threshold T was defined: $T = 0.5$ for proportional variables (range $[0,1]$) and $T = \text{median}(G)$ for continuous variables. Sampling sites were then divided into two groups (low: $G \leq T$; high: $G > T$), and the interaction model was constructed as:

$$Y_i = \beta_0 + \sum_{k=1}^p \beta_k X_{k,i} + \sum_{g=1}^s \gamma_g G_{g,i} + \sum_{k=1}^p \sum_{g=1}^s \delta_{kg} (X_{k,i} G_{g,i}) + \varepsilon_i$$

where G_{gi} represents the grouping variable (low/high), γ_g is the main effect of group, and δ_{kg} represents the interaction effect between environmental variable X and group.

Habitat type and interaction terms were included to test differences in environmental effects across habitats. Model significance was evaluated based on parameter estimates and p-values, and response curves were used to visualize the direction and strength of environmental effects.

S2 Supplementary Tables

Table S1 Number of sampling sites across temperature ranges and habitat types

MAT (°C)	Habitat			Total
	Natural	Semi-natural	Agricultural	
MAT≤9	4	2	2	8
9<MAT≤11	3	3	2	8
11<MAT≤13	2	4	2	8
13<MAT≤15	2	3	3	8
15<MAT	2	2	4	8
Total	13	14	13	40

Data in the table show the distribution of sampling sites across different temperature ranges and habitat types. “Natural”, “Semi-natural”, and “Agricultural” refer to the numbers of sampling sites in the corresponding habitat types, and “total” indicates the total number of sampling sites within each temperature range as well as the pooled total across habitat types. MAT is the average temperature for many years.

Table S2 Jaccard similarity index (C_j) and number of common species of three habitat types

Habitat	Agricultural	Natural	Semi-natural
agricultural	1	138	159
natural	0.2949	1	189
seminatural	0.3673	0.3443	1

The table shows species compositional similarity and the number of shared species among the three habitat types. Values in the lower triangle are Jaccard similarity indices (C_j), indicating the similarity in species composition between habitats, while values in the upper triangle represent the numbers of shared species between each pair of habitats.

Table S3 Statistical table of butterfly classification in Qinling Mountains

Family	Scientific Name	Abundance	Relative Abundance (%)
Pieridae	<i>Anthocharis scolymus</i>	11	0.24%
Pieridae	<i>Aporia crataegi</i>	28	0.62%
Pieridae	<i>Aporia largeteaudi</i>	70	1.55%
Pieridae	<i>Pieris canidia</i>	282	6.25%
Pieridae	<i>Pieris extensa</i>	3	0.07%
Pieridae	<i>Pieris melete</i>	41	0.91%
Pieridae	<i>Pieris rapae</i>	1074	23.79%
Pieridae	<i>Pontia edusa</i>	3	0.07%
Pieridae	<i>Colias fieldii</i>	159	3.52%

Family	Scientific Name	Abundance	Relative Abundance (%)
Pieridae	<i>Colias poliographus</i>	111	2.46%
Pieridae	<i>Eurema mandarina</i>	87	1.93%
Pieridae	<i>Gonepteryx amintha</i>	1	0.02%
Pieridae	<i>Gonepteryx aspasia</i>	1	0.02%
Pieridae	<i>Gonepteryx rhamni</i>	3	0.07%
Pieridae	<i>Terias hecabe</i>	287	6.36%
Pieridae	<i>Leptidea morsei</i>	24	0.53%
Papilionidae	<i>Byasa alcinous</i>	1	0.02%
Papilionidae	<i>Byasa confusa</i>	16	0.35%
Papilionidae	<i>Byasa mencius</i>	17	0.38%
Papilionidae	<i>Graphium agamemnon</i>	50	1.11%
Papilionidae	<i>Papilio bianor</i>	74	1.64%
Papilionidae	<i>Papilio maackii</i>	9	0.20%
Papilionidae	<i>Papilio machaon</i>	31	0.69%
Papilionidae	<i>Papilio macilentus</i>	1	0.02%
Papilionidae	<i>Papilio paris</i>	4	0.09%
Papilionidae	<i>Papilio polytes</i>	18	0.40%
Papilionidae	<i>Papilio protenor</i>	33	0.73%
Papilionidae	<i>Papilio xuthus</i>	172	3.81%
Papilionidae	<i>Pazala euroa</i>	1	0.02%
Papilionidae	<i>Troides aeacus</i>	6	0.13%
Papilionidae	<i>Parnassius glacialis</i>	36	0.80%
Lycaenidae	<i>Heliophorus eventa</i>	3	0.07%
Lycaenidae	<i>Heliophorus saphir</i>	5	0.11%
Lycaenidae	<i>Lycaena phlaeas</i>	62	1.37%
Lycaenidae	<i>Araragi enthea</i>	15	0.33%
Lycaenidae	<i>Neozephyrus japonicus</i>	1	0.02%
Lycaenidae	<i>Pseudogonerilia kitawakii</i>	8	0.18%
Lycaenidae	<i>Rapala caerulea</i>	1	0.02%
Lycaenidae	<i>Rapala nissa</i>	10	0.22%
Lycaenidae	<i>Rapala varuna</i>	3	0.07%
Lycaenidae	<i>Satyrium eximia</i>	1	0.02%
Lycaenidae	<i>Sinthusia chandrana</i>	5	0.11%
Lycaenidae	<i>Wagimo signatus</i>	8	0.18%
Lycaenidae	<i>Celastrina argiolus</i>	158	3.50%
Lycaenidae	<i>Cupido argiades</i>	99	2.19%

Family	Scientific Name	Abundance	Relative Abundance (%)
Lycaenidae	<i>Glaucoopsyche lycormas</i>	3	0.07%
Lycaenidae	<i>Lampides boeticus</i>	8	0.18%
Lycaenidae	<i>Niphanda fusca</i>	3	0.07%
Lycaenidae	<i>Orthomiella pontis</i>	5	0.11%
Lycaenidae	<i>Orthomiella sinensis</i>	4	0.09%
Lycaenidae	<i>Plebejus argus</i>	10	0.22%
Lycaenidae	<i>Plebejus argyrognomon</i>	3	0.07%
Lycaenidae	<i>Polyommatus amorata</i>	4	0.09%
Lycaenidae	<i>Polyommatus icarus</i>	4	0.09%
Lycaenidae	<i>Pseudozizeeria maha</i>	117	2.59%
Lycaenidae	<i>Scolitantides orion</i>	6	0.13%
Lycaenidae	<i>Tongeia filicaudis</i>	66	1.46%
Lycaenidae	<i>Tongeia fischeri</i>	8	0.18%
Lycaenidae	<i>Curetis acuta</i>	4	0.09%
Nymphalidae	<i>Charaxes bernardus</i>	1	0.02%
Nymphalidae	<i>Polyura narcaea</i>	17	0.38%
Nymphalidae	<i>Libythea lepita</i>	2	0.04%
Nymphalidae	<i>Araschnia doris</i>	2	0.04%
Nymphalidae	<i>Araschnia levana</i>	3	0.07%
Nymphalidae	<i>Kaniska canace</i>	4	0.09%
Nymphalidae	<i>Polygonia c-aureum</i>	314	6.95%
Nymphalidae	<i>Vanessa cardui</i>	7	0.16%
Nymphalidae	<i>Vanessa indica</i>	3	0.07%
Nymphalidae	<i>Calinaga davidis</i>	2	0.04%
Nymphalidae	<i>Apatura laverna</i>	2	0.04%
Nymphalidae	<i>Apatura metis</i>	4	0.09%
Nymphalidae	<i>Chitoria ulupi</i>	1	0.02%
Nymphalidae	<i>Hestina persimilis</i>	4	0.09%
Nymphalidae	<i>Lelecella limenitoides</i>	2	0.04%
Nymphalidae	<i>Mimathyma schrenckii</i>	2	0.04%
Nymphalidae	<i>Sasakia charonda</i>	1	0.02%
Nymphalidae	<i>Athyma fortuna</i>	1	0.02%
Nymphalidae	<i>Chalinga pratti</i>	1	0.02%
Nymphalidae	<i>Euthalia kardama</i>	12	0.27%
Nymphalidae	<i>Limenitis ciocolatina</i>	5	0.11%
Nymphalidae	<i>Limenitis doerriesi</i>	6	0.13%

Family	Scientific Name	Abundance	Relative Abundance (%)
Nymphalidae	<i>Limenitis helmanni</i>	143	3.17%
Nymphalidae	<i>Limenitis mimica</i>	1	0.02%
Nymphalidae	<i>Limenitis misuji</i>	2	0.04%
Nymphalidae	<i>Neptis alwina</i>	4	0.09%
Nymphalidae	<i>Neptis andetria</i>	1	0.02%
Nymphalidae	<i>Neptis armandia</i>	8	0.18%
Nymphalidae	<i>Neptis nemorosa</i>	2	0.04%
Nymphalidae	<i>Neptis philyra</i>	2	0.04%
Nymphalidae	<i>Neptis pryeri</i>	4	0.09%
Nymphalidae	<i>Neptis rivularis</i>	2	0.04%
Nymphalidae	<i>Neptis sankara</i>	1	0.02%
Nymphalidae	<i>Neptis sappho</i>	231	5.12%
Nymphalidae	<i>Neptis soma</i>	3	0.07%
Nymphalidae	<i>Neptis thisbe</i>	7	0.16%
Nymphalidae	<i>Coenonympha amaryllis</i>	3	0.07%
Nymphalidae	<i>Davidina armandi</i>	5	0.11%
Nymphalidae	<i>Kirinia epimenides</i>	3	0.07%
Nymphalidae	<i>Lethe albolineata</i>	1	0.02%
Nymphalidae	<i>Lethe christophi</i>	4	0.09%
Nymphalidae	<i>Lethe diana</i>	4	0.09%
Nymphalidae	<i>Lethe dura</i>	2	0.04%
Nymphalidae	<i>Lethe helle</i>	7	0.16%
Nymphalidae	<i>Lethe isana</i>	1	0.02%
Nymphalidae	<i>Lethe marginalis</i>	4	0.09%
Nymphalidae	<i>Lethe satyrina</i>	4	0.09%
Nymphalidae	<i>Lethe sidonis</i>	3	0.07%
Nymphalidae	<i>Lethe yunnana</i>	2	0.04%
Nymphalidae	<i>Lopinga achine</i>	5	0.11%
Nymphalidae	<i>Melanargia halimede</i>	7	0.16%
Nymphalidae	<i>Melanargia lugens</i>	14	0.31%
Nymphalidae	<i>Mycalesis francisca</i>	25	0.55%
Nymphalidae	<i>Mycalesis gotama</i>	29	0.64%
Nymphalidae	<i>Neope bremeri</i>	3	0.07%
Nymphalidae	<i>Neope pulaha</i>	1	0.02%
Nymphalidae	<i>Ninguta schrenckii</i>	3	0.07%
Nymphalidae	<i>Palaeonympha opalina</i>	6	0.13%

Family	Scientific Name	Abundance	Relative Abundance (%)
Nymphalidae	<i>Penthema adelma</i>	4	0.09%
Nymphalidae	<i>Penthema formosanum</i>	1	0.02%
Nymphalidae	<i>Stichopthalma neumogeni</i>	20	0.44%
Nymphalidae	<i>Tatinga thibetanus</i>	1	0.02%
Nymphalidae	<i>Ypthima argus</i>	8	0.18%
Nymphalidae	<i>Ypthima baldus</i>	30	0.66%
Nymphalidae	<i>Ypthima conjuncta</i>	8	0.18%
Nymphalidae	<i>Ypthima lisandra</i>	4	0.09%
Nymphalidae	<i>Ypthima multistriata</i>	34	0.75%
Nymphalidae	<i>Argynnis adippe</i>	5	0.11%
Nymphalidae	<i>Argynnis hyperbius</i>	5	0.11%
Nymphalidae	<i>Argynnis paphia</i>	10	0.22%
Nymphalidae	<i>Argynnis ruslana</i>	6	0.13%
Nymphalidae	<i>Argynnis sagana</i>	6	0.13%
Nymphalidae	<i>Argynnis vorax</i>	1	0.02%
Nymphalidae	<i>Telchinia issoria</i>	14	0.31%
Hesperiidae	<i>Erynnis montanus</i>	5	0.11%
Hesperiidae	<i>Pyrgus maculatus</i>	1	0.02%
Hesperiidae	<i>Ampittia virgata</i>	1	0.02%
Hesperiidae	<i>Ochlodes ochracea</i>	1	0.02%
Hesperiidae	<i>Ochlodes similis</i>	9	0.20%
Hesperiidae	<i>Ochlodes subhyalina</i>	6	0.13%
Hesperiidae	<i>Parnara ganga</i>	4	0.09%
Hesperiidae	<i>Parnara guttata</i>	11	0.24%
Hesperiidae	<i>Pelopidas agna</i>	24	0.53%
Hesperiidae	<i>Pelopidas sinensis</i>	1	0.02%
Hesperiidae	<i>Polytremis eltola</i>	4	0.09%
Hesperiidae	<i>Polytremis lubricans</i>	3	0.07%
Hesperiidae	<i>Daimio tethys</i>	16	0.35%
Hesperiidae	<i>Lobocla bifasciata</i>	29	0.64%
Riodinidae	<i>Abisara fylloides</i>	11	0.24%
Riodinidae	<i>Dodona egeon</i>	3	0.07%
Riodinidae	<i>Takashia nana</i>	2	0.04%

The table presents the family name, scientific name, abundance, and relative abundance of the insect group in the Qinling Mountains. Abundance refers to the number of individuals recorded for each species across all sampling sites, and relative abundance refers to the percentage of individuals of each species in the total individuals of the corresponding group.

Table S4 Statistical table of Hymenoptera pollinators in Qinling Mountains

Family	Scientific Name	Abundance	Relative Abundance (%)
Eumenidae	<i>Antepipona bipustulata</i>	1	0.05%
Eumenidae	<i>Anterhynchium flavomarginatum</i>	4	0.21%
Eumenidae	<i>Anterhynchium inamurai</i>	3	0.16%
Eumenidae	<i>Apodynerus formosensis</i>	1	0.05%
Eumenidae	<i>Discoelius zonalis</i>	4	0.21%
Eumenidae	<i>Eumenes coronatus</i>	1	0.05%
Eumenidae	<i>Eumenes labiatus</i>	7	0.37%
Eumenidae	<i>Eumenes mediterraneus</i>	1	0.05%
Eumenidae	<i>Eumenes pedunculatus</i>	1	0.05%
Eumenidae	<i>Eumenes punctatus</i>	2	0.10%
Eumenidae	<i>Eumenes rubronotatus</i>	2	0.10%
Eumenidae	<i>Euodynerus nipanicus</i>	1	0.05%
Eumenidae	<i>Euodynerus trilobus</i>	1	0.05%
Eumenidae	<i>Orancistrocerus drewseni</i>	1	0.05%
Eumenidae	<i>Oreumenes decoratus</i>	5	0.26%
Eumenidae	<i>Parancistrocerus perennis</i>	1	0.05%
Eumenidae	<i>Rhynchium quinquecinctum</i>	4	0.21%
Eumenidae	<i>Vespa basalis</i>	27	1.41%
Eumenidae	<i>Vespa bicolor</i>	1	0.05%
Eumenidae	<i>Vespa crabro</i>	1	0.05%
Eumenidae	<i>Vespa velutina</i>	8	0.42%
Eumenidae	<i>Vespula flaviceps</i>	31	1.62%
Eumenidae	<i>Vespula koreensis</i>	1	0.05%
Eumenidae	<i>Parapolybia varia</i>	24	1.26%
Eumenidae	<i>Polistes chinensis</i>	2	0.10%
Eumenidae	<i>Polistes fuscatus</i>	1	0.05%
Eumenidae	<i>Polistes gigas</i>	1	0.05%
Eumenidae	<i>Polistes japonicus</i>	1	0.05%
Eumenidae	<i>Polistes rothneyi</i>	5	0.26%
Eumenidae	<i>Polistes snelleni</i>	62	3.24%
Andrenidae	<i>Andrena thoracica</i>	1	0.05%
Crabronidae	<i>Cerceris hortivaga</i>	2	0.10%
Crabronidae	<i>Cerceris insolita</i>	1	0.05%
Crabronidae	<i>Cerceris pictiventris</i>	2	0.10%
Crabronidae	<i>Philanthus triangulum</i>	4	0.21%

Family	Scientific Name	Abundance	Relative Abundance (%)
Crabronidae	<i>Ectemnius continuus</i>	1	0.05%
Colletidae	<i>Hylaeus verticalis</i>	17	0.89%
Apidae	<i>Amegilla mesopyrrha</i>	1	0.05%
Apidae	<i>Anthophora villosula</i>	16	0.84%
Apidae	<i>Apis andreniformis</i>	1	0.05%
Apidae	<i>Apis cerana</i>	813	42.54%
Apidae	<i>Apis mellifera</i>	402	21.04%
Apidae	<i>Bombus atripes</i>	3	0.16%
Apidae	<i>Bombus bicoloratus</i>	1	0.05%
Apidae	<i>Bombus eximius</i>	2	0.10%
Apidae	<i>Bombus ignitus</i>	36	1.88%
Apidae	<i>Bombus impatiens</i>	2	0.10%
Apidae	<i>Bombus pyrosoma</i>	7	0.37%
Apidae	<i>Bombus trifasciatus</i>	26	1.36%
Apidae	<i>Eucera longicornis</i>	72	3.77%
Apidae	<i>Habropoda mimetica</i>	5	0.26%
Apidae	<i>Thyreus himalayensis</i>	1	0.05%
Apidae	<i>Ceratina strenua</i>	9	0.47%
Apidae	<i>Xylocopa appendiculata</i>	42	2.20%
Apidae	<i>Xylocopa rufipes</i>	10	0.52%
Apidae	<i>Xylocopa tranquebarorum</i>	5	0.26%
Apidae	<i>Xylocopa virginica</i>	1	0.05%
Megachilidae	<i>Anthidium florentinum</i>	4	0.21%
Megachilidae	<i>Coelioxys afer</i>	1	0.05%
Megachilidae	<i>Euaspis basalis</i>	12	0.63%
Megachilidae	<i>Euaspis polynesia</i>	2	0.10%
Megachilidae	<i>Megachile rotundata</i>	1	0.05%
Megachilidae	<i>Megachile sculpturalis</i>	1	0.05%
Megachilidae	<i>Megachile willughbiella</i>	1	0.05%
Halictidae	<i>Lipotriches ceratina</i>	2	0.10%
Halictidae	<i>Nomia chalybeata</i>	2	0.10%
Halictidae	<i>Nomia incerta</i>	1	0.05%
Halictidae	<i>Nomia iridescens</i>	2	0.10%
Halictidae	<i>Nomia thoracica</i>	5	0.26%
Halictidae	<i>Halictus rubicundus</i>	1	0.05%
Halictidae	<i>Halictus tumulorum</i>	171	8.95%

Family	Scientific Name	Abundance	Relative Abundance (%)
Halictidae	<i>Lasioglossum politum</i>	3	0.16%
Halictidae	<i>Sphecodes monilicornis</i>	1	0.05%
Tenthredinidae	<i>Athalia proxima</i>	6	0.31%
Tenthredinidae	<i>Dolerus cameroni</i>	4	0.21%

The table presents the family name, scientific name, abundance, and relative abundance of the insect group in the Qinling Mountains. Abundance refers to the number of individuals recorded for each species across all sampling sites, and relative abundance refers to the percentage of individuals of each species in the total individuals of the corresponding group.

Table S5 Statistical classification of Coleoptera pollinators in Qinling Mountains

Family	Scientific Name	Abundance	Relative Abundance (%)
Cleridae	<i>Opilo pallidus</i>	1	0.07%
Cleridae	<i>Trichodes sinae</i>	2	0.13%
Cleridae	<i>Cladiscus pallidicornis</i>	1	0.07%
Byturidae	<i>Byturus unicolor</i>	1	0.07%
Scarabaeidae	<i>Campsiura mirabilis</i>	1	0.07%
Scarabaeidae	<i>Dicronocephalus adamsi</i>	24	1.58%
Scarabaeidae	<i>Gametis jucunda</i>	3	0.20%
Scarabaeidae	<i>Glycyphana fulvistemma</i>	1	0.07%
Scarabaeidae	<i>Protaetia brevitarsis</i>	1	0.07%
Scarabaeidae	<i>Protaetia mandschuriensis</i>	12	0.79%
Scarabaeidae	<i>Protaetia orientalis</i>	9	0.59%
Scarabaeidae	<i>Pseudotorynorrhina japonica</i>	2	0.13%
Scarabaeidae	<i>Maladera (cephaloserica) pernicioso</i>	1	0.07%
Scarabaeidae	<i>Adoretus tenuimaculatus</i>	1	0.07%
Scarabaeidae	<i>Anomala corpulenta</i>	2	0.13%
Scarabaeidae	<i>Anomala sulcipennnis</i>	8	0.53%
Scarabaeidae	<i>Anomala trivirgata</i>	6	0.39%
Scarabaeidae	<i>Anthrenus verbasci</i>	1	0.07%
Scarabaeidae	<i>Callistethus plagiicollis</i>	6	0.39%
Scarabaeidae	<i>Mimela excisipes</i>	2	0.13%
Scarabaeidae	<i>Mimela splendens</i>	3	0.20%
Scarabaeidae	<i>Popillia mutans</i>	5	0.33%
Scarabaeidae	<i>Holotrichia parallela</i>	5	0.33%
Scarabaeidae	<i>Maladera orientalis</i>	2	0.13%
Scarabaeidae	<i>Melolontha incana</i>	1	0.07%

Family	Scientific Name	Abundance	Relative Abundance (%)
Scarabaeidae	<i>Trypoxylus dichotomus</i>	1	0.07%
Glaphyridae	<i>Amphicoma fairmairei</i>	2	0.13%
Lycidae	<i>Dictyoptera aurora</i>	2	0.13%
Lycidae	<i>Porrostoma rufipenne</i>	1	0.07%
Cantharidae	<i>Cantharis pulicaria</i>	1	0.07%
Cantharidae	<i>Cultellunguis perpallens</i>	6	0.39%
Cantharidae	<i>Lycocerus asperipennis</i>	2	0.13%
Cantharidae	<i>Lycocerus gressitti</i>	1	0.07%
Cantharidae	<i>Lycocerus pubicollis</i>	8	0.53%
Cantharidae	<i>Micropodabrus obscurior</i>	1	0.07%
Cantharidae	<i>Podabrus brunnicollis</i>	1	0.07%
Cantharidae	<i>Prothemus chinensis</i>	1	0.07%
Cantharidae	<i>Prothemus purpureipennis</i>	4	0.26%
Cantharidae	<i>Rhagonycha kiesewetteri</i>	1	0.07%
Cantharidae	<i>Rhagonycha nigrohumeralis</i>	5	0.33%
Cantharidae	<i>Themus impressipennis</i>	3	0.20%
Cantharidae	<i>Themus leechianus</i>	2	0.13%
Cantharidae	<i>Themus luteipes</i>	3	0.20%
Cantharidae	<i>Themus stigmaticus</i>	1	0.07%
Cantharidae	<i>Ichthyurus klapperichi</i>	1	0.07%
Pyrochroidae	<i>Eupyrochroa insignita</i>	2	0.13%
Pyrochroidae	<i>Pyrochroa serraticornis</i>	2	0.13%
Mordellidae	<i>Mordella argentipunctata</i>	1	0.07%
Mordellidae	<i>Mordella holomelaena</i>	140	9.20%
Tenebrionidae	<i>Cerogria janthinipennis</i>	1	0.07%
Tenebrionidae	<i>Lagria formosensis</i>	47	3.09%
Tenebrionidae	<i>Lagria hirta</i>	49	3.22%
Tenebrionidae	<i>Lagria oharai</i>	4	0.26%
Tenebrionidae	<i>Cistelina davidis</i>	1	0.07%
Tenebrionidae	<i>Cteniopinus hypocrita</i>	6	0.39%
Oedemeridae	<i>Anogcodes seladonius</i>	5	0.33%
Oedemeridae	<i>Nacerdes waterhousei</i>	1	0.07%
Oedemeridae	<i>Oedemera testaceithorax</i>	4	0.26%
Oedemeridae	<i>Oedemera virescens ssp.</i>	25	1.64%
Cerambycidae	<i>Acalolepta cervina</i>	1	0.07%
Cerambycidae	<i>Agapanthia amurensis</i>	10	0.66%

Family	Scientific Name	Abundance	Relative Abundance (%)
Cerambycidae	<i>Anoplophora chinensis</i>	2	0.13%
Cerambycidae	<i>Astynoscelis degener</i>	3	0.20%
Cerambycidae	<i>Atimura japonica</i>	1	0.07%
Cerambycidae	<i>Oberea fuscipennis</i>	2	0.13%
Cerambycidae	<i>Penthides flavus</i>	1	0.07%
Cerambycidae	<i>Phytoecia rufiventris</i>	10	0.66%
Cerambycidae	<i>Psacotheta hilaris</i>	3	0.20%
Cerambycidae	<i>Pterolophia dalbergicola</i>	2	0.13%
Cerambycidae	<i>Rhopaloscelis maculatus</i>	3	0.20%
Cerambycidae	<i>Tetraophthalmus episcopalis</i>	1	0.07%
Cerambycidae	<i>Thyestilla gebleri</i>	2	0.13%
Cerambycidae	<i>Carilia tuberculicollis</i>	1	0.07%
Cerambycidae	<i>Aegosoma sinicum</i>	1	0.07%
Cerambycidae	<i>Chlorophorus diadema diadema</i>	4	0.26%
Cerambycidae	<i>Chlorophorus simillimus</i>	2	0.13%
Cerambycidae	<i>Chlorophorus viridulus</i>	2	0.13%
Cerambycidae	<i>Dere thoracica</i>	1	0.07%
Cerambycidae	<i>Grammographus notabilis cuneatus</i>	1	0.07%
Cerambycidae	<i>Nupserha infantula</i>	16	1.05%
Cerambycidae	<i>Purpuricenus temminckii</i>	2	0.13%
Cerambycidae	<i>Xylotrechus grayii</i>	1	0.07%
Cerambycidae	<i>Plaxomicrus ellipticus</i>	1	0.07%
Cerambycidae	<i>Terinaea tiliae</i>	1	0.07%
Curculionidae	<i>Listroderes costirostris</i>	2	0.13%
Curculionidae	<i>Cosmobaris scolopacea</i>	1	0.07%
Curculionidae	<i>Calomycterus setarius</i>	22	1.45%
Curculionidae	<i>Chlorophanus sibiricus</i>	11	0.72%
Curculionidae	<i>Cyrtepistomus castaneus</i>	36	2.37%
Curculionidae	<i>Pantomorus cervinus</i>	1	0.07%
Curculionidae	<i>Sitona striatellus</i>	6	0.39%
Curculionidae	<i>Tanymecus palliatus</i>	1	0.07%
Curculionidae	<i>Metialma cordata</i>	6	0.39%
Curculionidae	<i>Lixus maculatus</i>	4	0.26%
Curculionidae	<i>Lixus subtilis</i>	5	0.33%
Curculionidae	<i>Rhinoncus pericarpus</i>	1	0.07%
Curculionidae	<i>Demimaea fascicularis</i>	1	0.07%

Family	Scientific Name	Abundance	Relative Abundance (%)
Curculionidae	<i>Hypera conmaculata</i>	1	0.07%
Anthribidae	<i>Araecerus fasciculatus</i>	1	0.07%
Chrysomelidae	<i>Aoria bowringii</i>	3	0.20%
Chrysomelidae	<i>Aoria rufotestacea</i>	28	1.84%
Chrysomelidae	<i>Physosmaragdina nigrifrons</i>	229	15.05%
Chrysomelidae	<i>Acanthoscelides compressicornis</i>	4	0.26%
Chrysomelidae	<i>Bruchidius comptus</i>	1	0.07%
Chrysomelidae	<i>Bruchus pisorum</i>	27	1.77%
Chrysomelidae	<i>Bruchus rufimanus</i>	15	0.99%
Chrysomelidae	<i>Callosobruchus chinensis</i>	5	0.33%
Chrysomelidae	<i>Cassida fusciorufa</i>	5	0.33%
Chrysomelidae	<i>Cassida nebulosa</i>	3	0.20%
Chrysomelidae	<i>Cassida piperata</i>	3	0.20%
Chrysomelidae	<i>Cassida rubiginosa</i>	1	0.07%
Chrysomelidae	<i>Lacoptera nepalensis</i>	5	0.33%
Chrysomelidae	<i>Ophrida xanthospilota</i>	1	0.07%
Chrysomelidae	<i>Systema gracilentia</i>	1	0.07%
Chrysomelidae	<i>Basilepta fulvipes</i>	31	2.04%
Chrysomelidae	<i>Basilepta hirayamai</i>	2	0.13%
Chrysomelidae	<i>Basilepta leechi</i>	4	0.26%
Chrysomelidae	<i>Basilepta ruficollis</i>	3	0.20%
Chrysomelidae	<i>Bromius obscurus</i>	4	0.26%
Chrysomelidae	<i>Chrysochus asclepiadeus</i>	2	0.13%
Chrysomelidae	<i>Colasposoma viridicoeruleum</i>	5	0.33%
Chrysomelidae	<i>Dactylispa angulosa</i>	1	0.07%
Chrysomelidae	<i>Heteraspis lewisii</i>	11	0.72%
Chrysomelidae	<i>Paria scutellaris</i>	1	0.07%
Chrysomelidae	<i>Platycorynus parryi</i>	2	0.13%
Chrysomelidae	<i>Platycorynus peregrinus</i>	2	0.13%
Chrysomelidae	<i>Pseudocophora pectoralis</i>	4	0.26%
Chrysomelidae	<i>Trichochrysea imperialis</i>	2	0.13%
Chrysomelidae	<i>Trichochrysea japana</i>	1	0.07%
Chrysomelidae	<i>Chrysolina aurichalcea</i>	30	1.97%
Chrysomelidae	<i>Chrysomela salicivorax</i>	3	0.20%
Chrysomelidae	<i>Chrysomela vigintipunctata</i>	3	0.20%
Chrysomelidae	<i>Colaphellus sophiae</i>	3	0.20%

Family	Scientific Name	Abundance	Relative Abundance (%)
Chrysomelidae	<i>Gastrolina depressa</i>	1	0.07%
Chrysomelidae	<i>Gastrophysa polygona</i>	3	0.20%
Chrysomelidae	<i>Gonioctena flavipennis</i>	1	0.07%
Chrysomelidae	<i>Phola octodecimguttata</i>	1	0.07%
Chrysomelidae	<i>Plagioderia versicolora</i>	5	0.33%
Chrysomelidae	<i>Clytra quadripunctata</i>	1	0.07%
Chrysomelidae	<i>Cryptocephalus elegantulus</i>	2	0.13%
Chrysomelidae	<i>Cryptocephalus koltzei</i>	4	0.26%
Chrysomelidae	<i>Cryptocephalus laetus</i>	1	0.07%
Chrysomelidae	<i>Cryptocephalus limbellus</i>	2	0.13%
Chrysomelidae	<i>Adoxia femoralis</i>	3	0.20%
Chrysomelidae	<i>Agelasa nigriceps</i>	1	0.07%
Chrysomelidae	<i>Altica obliterata</i>	1	0.07%
Chrysomelidae	<i>Altica oleracea</i>	12	0.79%
Chrysomelidae	<i>Aphthona lutescens</i>	2	0.13%
Chrysomelidae	<i>Aphthona nonstriata</i>	2	0.13%
Chrysomelidae	<i>Arthrotus abdominalis</i>	34	2.23%
Chrysomelidae	<i>Arthrotus chinensis</i>	1	0.07%
Chrysomelidae	<i>Arthrotus nigrofasciatus</i>	1	0.07%
Chrysomelidae	<i>Atrachya menetriesii</i>	1	0.07%
Chrysomelidae	<i>Aulacophora indica</i>	66	4.34%
Chrysomelidae	<i>Aulacophora lewisii</i>	35	2.30%
Chrysomelidae	<i>Aulacophora nigripennis</i>	6	0.39%
Chrysomelidae	<i>Burumoseria yuae</i>	1	0.07%
Chrysomelidae	<i>Chaetocnema hortensis</i>	1	0.07%
Chrysomelidae	<i>Cneorane elegans</i>	48	3.15%
Chrysomelidae	<i>Dibolia borealis</i>	1	0.07%
Chrysomelidae	<i>Fleutiauxia armata</i>	4	0.26%
Chrysomelidae	<i>Galerucella grisescens</i>	2	0.13%
Chrysomelidae	<i>Gallerucida bifasciata</i>	21	1.38%
Chrysomelidae	<i>Hemipyxis plagioderoides</i>	2	0.13%
Chrysomelidae	<i>Liroetis aeneipennis</i>	5	0.33%
Chrysomelidae	<i>Longitarsus succineus</i>	35	2.30%
Chrysomelidae	<i>Luperomorpha xanthodera</i>	7	0.46%
Chrysomelidae	<i>Monolepta bicavipennis</i>	4	0.26%
Chrysomelidae	<i>Monolepta gracilipes</i>	1	0.07%

Family	Scientific Name	Abundance	Relative Abundance (%)
Chrysomelidae	<i>Monolepta parvezi</i>	1	0.07%
Chrysomelidae	<i>Monolepta quadriguttata</i>	15	0.99%
Chrysomelidae	<i>Monolepta tsoui</i>	5	0.33%
Chrysomelidae	<i>Nonarthra cyanea</i>	11	0.72%
Chrysomelidae	<i>Oides bowringii</i>	2	0.13%
Chrysomelidae	<i>Oides decempunctata</i>	46	3.02%
Chrysomelidae	<i>Pagria signata</i>	1	0.07%
Chrysomelidae	<i>Paleosepharia excavata</i>	8	0.53%
Chrysomelidae	<i>Paleosepharia posticata</i>	3	0.20%
Chrysomelidae	<i>Paridea angulicollis</i>	1	0.07%
Chrysomelidae	<i>Paridea costata</i>	13	0.85%
Chrysomelidae	<i>Paridea oculata</i>	3	0.20%
Chrysomelidae	<i>Phygasia fulvipennis</i>	1	0.07%
Chrysomelidae	<i>Phygasia ornata</i>	2	0.13%
Chrysomelidae	<i>Phyllotreta cruciferae</i>	19	1.25%
Chrysomelidae	<i>Podagrica fuscicornis</i>	8	0.53%
Chrysomelidae	<i>Podontia lutea</i>	2	0.13%
Chrysomelidae	<i>Pyrrhalta maculicollis</i>	2	0.13%
Chrysomelidae	<i>Sphaeroderma separatum</i>	3	0.20%
Chrysomelidae	<i>Xanthogaleruca aenescens</i>	1	0.07%
Staphylinidae	<i>Creophilus flavipennis</i>	1	0.07%
Bostrichidae	<i>Xylothrips flavipes</i>	1	0.07%

The table presents the family name, scientific name, abundance, and relative abundance of the insect group in the Qinling Mountains. Abundance refers to the number of individuals recorded for each species across all sampling sites, and relative abundance refers to the percentage of individuals of each species in the total individuals of the corresponding group.

Table S6 Statistical classification of Diptera pollinators in Qinling Mountains

Family	Scientific Name	Abundance	Relative Abundance (%)
Tachinidae	<i>Demoticoidea pallidus</i>	2	0.19%
Tachinidae	<i>Dexiosoma caninum</i>	3	0.29%
Tachinidae	<i>Gymnocheta viridis</i>	1	0.10%
Tachinidae	<i>Gymnosoma dolycoridis</i>	2	0.19%
Tachinidae	<i>Gymnosoma nudifrons</i>	1	0.10%
Tachinidae	<i>Nemoraea pellucida</i>	1	0.10%
Tachinidae	<i>Peleteria iavana</i>	1	0.10%

Family	Scientific Name	Abundance	Relative Abundance (%)
Tachinidae	<i>Cylindromyia brassicaria</i>	3	0.29%
Tachinidae	<i>Cylindromyia umbripennis</i>	1	0.10%
Tachinidae	<i>Ectophasia rotundiventris</i>	2	0.19%
Tachinidae	<i>Gymnosoma rotundatum</i>	30	2.89%
Tachinidae	<i>Phasia obesa</i>	2	0.19%
Tachinidae	<i>Thelaira nigripes</i>	2	0.19%
Tachinidae	<i>Medina collaris</i>	1	0.10%
Calliphoridae	<i>Stomorhina discolor</i>	211	20.33%
Calliphoridae	<i>Chrysomya megacephala</i>	2	0.19%
Calliphoridae	<i>Chrysomya rufifacies</i>	4	0.39%
Sarcophagidae	<i>Sarcophaga africa</i>	3	0.29%
Sarcophagidae	<i>Wohlfahrtia magnifica</i>	1	0.10%
Platystomatidae	<i>Platystoma mandschuricum</i>	1	0.10%
Platystomatidae	<i>Platystoma seminationis</i>	1	0.10%
Platystomatidae	<i>Pterogenia hologaster</i>	2	0.19%
Platystomatidae	<i>Rivellia alini</i>	16	1.54%
Platystomatidae	<i>Rivellia apicalis</i>	23	2.22%
Platystomatidae	<i>Rivellia basilaris</i>	4	0.39%
Platystomatidae	<i>Rivellia mandschurica</i>	1	0.10%
Tephritidae	<i>Zeugodacus scutellatus</i>	3	0.29%
Tephritidae	<i>Zeugodacus tau</i>	1	0.10%
Tephritidae	<i>Campiglossa sororcula</i>	3	0.29%
Tephritidae	<i>Sphaeniscus atilius</i>	37	3.56%
Tephritidae	<i>Tephritis femoralis</i>	1	0.10%
Tephritidae	<i>Trupanea amoena</i>	6	0.58%
Tephritidae	<i>Rhagoletis alternata</i>	1	0.10%
Ulidiidae	<i>Seioptera vibrans</i>	7	0.67%
Bombyliidae	<i>Bombylius major</i>	12	1.16%
Bombyliidae	<i>Bombylius pygmaeus</i>	4	0.39%
Bombyliidae	<i>Anthrax aygulus</i>	1	0.10%
Bombyliidae	<i>Hemipenthes maura</i>	1	0.10%
Bombyliidae	<i>Systropus curvittatus</i>	2	0.19%
Bombyliidae	<i>Systropus denticulatus</i>	1	0.10%
Bombyliidae	<i>Systropus eurypterus</i>	3	0.29%
Bombyliidae	<i>Systropus excisus</i>	1	0.10%
Syrphidae	<i>Cheilosia pagana</i>	1	0.10%

Family	Scientific Name	Abundance	Relative Abundance (%)
Syrphidae	<i>Eristalis arbustorum</i>	5	0.48%
Syrphidae	<i>Eristalis cerealis</i>	17	1.64%
Syrphidae	<i>Eristalis tenax</i>	77	7.42%
Syrphidae	<i>Ferdinandea cuprea</i>	4	0.39%
Syrphidae	<i>Helophilus eristaloidea</i>	11	1.06%
Syrphidae	<i>Phytomia errans</i>	1	0.10%
Syrphidae	<i>Phytomia zonata</i>	5	0.48%
Syrphidae	<i>Syritta pipiens</i>	12	1.16%
Syrphidae	<i>Xylota coquilletti</i>	1	0.10%
Syrphidae	<i>Baccha maculata</i>	3	0.29%
Syrphidae	<i>Betasyrphus serarius</i>	2	0.19%
Syrphidae	<i>Chrysotoxum testaceum</i>	1	0.10%
Syrphidae	<i>Episyrphus balteatus</i>	33	3.18%
Syrphidae	<i>Eupeodes confrater</i>	3	0.29%
Syrphidae	<i>Eupeodes corollae</i>	132	12.72%
Syrphidae	<i>Eupeodes latifasciatus</i>	14	1.35%
Syrphidae	<i>Eupeodes nuba</i>	1	0.10%
Syrphidae	<i>Ischiodon scutellaris</i>	1	0.10%
Syrphidae	<i>Lapposyrphus lapponicus</i>	1	0.10%
Syrphidae	<i>Melanostoma mellinum</i>	8	0.77%
Syrphidae	<i>Parasyrphus annulatus</i>	1	0.10%
Syrphidae	<i>Platycheirus albimanus</i>	10	0.96%
Syrphidae	<i>Scaeva pyrastris</i>	2	0.19%
Syrphidae	<i>Scaeva selenitica</i>	1	0.10%
Syrphidae	<i>Sphaerophoria indiana</i>	1	0.10%
Syrphidae	<i>Sphaerophoria taeniata</i>	142	13.68%
Syrphidae	<i>Syrphus ribesii</i>	3	0.29%
Syrphidae	<i>Syrphus torvus</i>	1	0.10%
Syrphidae	<i>Pipiza quadrimaculata</i>	1	0.10%
Acroceridae	<i>Acrocera orbiculus</i>	1	0.10%
Scathophagidae	<i>Scathophaga stercoraria</i>	64	6.17%
Muscidae	<i>Coenosia tigrina</i>	3	0.29%
Muscidae	<i>Orchisia costata</i>	2	0.19%
Muscidae	<i>Atherigona reversura</i>	24	2.31%
Muscidae	<i>Musca autumnalis</i>	6	0.58%
Muscidae	<i>Graphomya rufitibia</i>	9	0.87%

Family	Scientific Name	Abundance	Relative Abundance (%)
Syrphidae	<i>Eristalinus arvorum</i>	2	0.19%
Syrphidae	<i>Eristalinus sepulchralis</i>	1	0.10%
Syrphidae	<i>Eumerus strigatus</i>	1	0.10%
Syrphidae	<i>Orhonevra elegans</i>	1	0.10%
Syrphidae	<i>Allograpta javana</i>	1	0.10%
Syrphidae	<i>Melanostoma scalare</i>	5	0.48%
Syrphidae	<i>Paragus albifrons</i>	2	0.19%
Syrphidae	<i>Paragus politus</i>	3	0.29%
Syrphidae	<i>Paragus quadrifasciatus</i>	1	0.10%
Syrphidae	<i>Paragus tibialis</i>	11	1.06%

The table presents the family name, scientific name, abundance, and relative abundance of the insect group in the Qinling Mountains. Abundance refers to the number of individuals recorded for each species across all sampling sites, and relative abundance refers to the percentage of individuals of each species in the total individuals of the corresponding group.

Table S7 Statistical classification of Hemiptera pollinators in Qinling Mountains

Family	Scientific Name	Abundance	Relative Abundance (%)
Pentatomidae	<i>Aelia fieberi</i>	12	0.35%
Pentatomidae	<i>Carbula humerigera</i>	72	2.08%
Pentatomidae	<i>Carpocoris purpureipennis</i>	2	0.06%
Pentatomidae	<i>Dolycoris baccarum</i>	48	1.39%
Pentatomidae	<i>Erthesina fullo</i>	3	0.09%
Pentatomidae	<i>Eurydema dominulus</i>	102	2.95%
Pentatomidae	<i>Eurydema gebleri</i>	19	0.55%
Pentatomidae	<i>Eurydema qinlingensis</i>	3	0.09%
Pentatomidae	<i>Eysarcoris guttigerus</i>	156	4.51%
Pentatomidae	<i>Eysarcoris ventralis</i>	1	0.03%
Pentatomidae	<i>Halyomorpha halys</i>	21	0.61%
Pentatomidae	<i>Homalagonia obtusa</i>	10	0.29%
Pentatomidae	<i>Hoplistodera pulchra</i>	1	0.03%
Pentatomidae	<i>Menida disjecta</i>	7	0.20%
Pentatomidae	<i>Menida violacea</i>	29	0.84%
Pentatomidae	<i>Nezara viridula</i>	5	0.14%
Pentatomidae	<i>Palomena viridissima</i>	6	0.17%
Pentatomidae	<i>Pentatoma semiannulata</i>	1	0.03%
Pentatomidae	<i>Piezodorus lituratus</i>	1	0.03%

Family	Scientific Name	Abundance	Relative Abundance (%)
Pentatomidae	<i>Plautia crossota</i>	12	0.35%
Pentatomidae	<i>Plautia stali</i>	20	0.58%
Pentatomidae	<i>Rubiconia intermedia</i>	20	0.58%
Pentatomidae	<i>Stagonomus gibbosus</i>	6	0.17%
Pentatomidae	<i>Dybowskyia reticulata</i>	56	1.62%
Pentatomidae	<i>Graphosoma rubrolineatum</i>	130	3.76%
Pentatomidae	<i>Arma custos</i>	1	0.03%
Pentatomidae	<i>Arma koreana</i>	3	0.09%
Pentatomidae	<i>Picromerus lewisi</i>	1	0.03%
Pentatomidae	<i>Zicrona caerulea</i>	3	0.09%
Miridae	<i>Bothynotus pilosus</i>	51	1.47%
Miridae	<i>Deraeocoris annulipes</i>	3	0.09%
Miridae	<i>Deraeocoris ater</i>	31	0.90%
Miridae	<i>Deraeocoris punctulatus</i>	69	1.99%
Miridae	<i>Deraeocoris ruber</i>	14	0.40%
Miridae	<i>Deraeocoris scutellaris</i>	3	0.09%
Miridae	<i>Deraeocoris serenus</i>	4	0.12%
Miridae	<i>Orthocephalus funestus</i>	41	1.18%
Miridae	<i>Adelphocoris fasciaticollis</i>	7	0.20%
Miridae	<i>Adelphocoris lineolatus</i>	21	0.61%
Miridae	<i>Adelphocoris nigritylus</i>	9	0.26%
Miridae	<i>Adelphocoris suturalis</i>	39	1.13%
Miridae	<i>Adelphocoris tenebrosus</i>	7	0.20%
Miridae	<i>Adelphocoris triannulatus</i>	61	1.76%
Miridae	<i>Apolygus hilaris</i>	7	0.20%
Miridae	<i>Apolygus lucorum</i>	97	2.80%
Miridae	<i>Capsus wagneri</i>	1	0.03%
Miridae	<i>Charagochilus angusticollis</i>	93	2.69%
Miridae	<i>Charagochilus gyllenhalii</i>	27	0.78%
Miridae	<i>Cheilocapsus tibetanus</i>	2	0.06%
Miridae	<i>Eurystylus coelestialium</i>	4	0.12%
Miridae	<i>Eurystylus sauteri</i>	2	0.06%
Miridae	<i>Lygus maritimus</i>	4	0.12%
Miridae	<i>Lygus pratensis</i>	12	0.35%
Miridae	<i>Lygus rugulipennis</i>	6	0.17%
Miridae	<i>Mermitelocerus annulipes</i>	93	2.69%

Family	Scientific Name	Abundance	Relative Abundance (%)
Miridae	<i>Neolygus contaminatus</i>	2	0.06%
Miridae	<i>Notostira elongata</i>	1	0.03%
Miridae	<i>Pantilius tunicatus</i>	1	0.03%
Miridae	<i>Polymerus cognatus</i>	5	0.14%
Miridae	<i>Polymerus nigrita</i>	1	0.03%
Miridae	<i>Polymerus pekinensis</i>	4	0.12%
Miridae	<i>Rhabdomiris striatellus</i>	18	0.52%
Miridae	<i>Stenodema calcarata</i>	1	0.03%
Miridae	<i>Stenodema pilosa</i>	1	0.03%
Miridae	<i>Trigonotylus caelestialium</i>	3	0.09%
Miridae	<i>Chlamydatus pulicarius</i>	4	0.12%
Miridae	<i>Europiella artemisiae</i>	18	0.52%
Coreidae	<i>Coriomeris scabricornis</i>	1	0.03%
Coreidae	<i>Acanthocoris scaber</i>	4	0.12%
Coreidae	<i>Anoplocnemis phasianus</i>	2	0.06%
Coreidae	<i>Cletus punctiger</i>	393	11.35%
Coreidae	<i>Coreus marginatus</i>	1	0.03%
Coreidae	<i>Coreus potanini</i>	1	0.03%
Coreidae	<i>Derepteryx obscurata</i>	1	0.03%
Coreidae	<i>Homoeocerus bipunctatus</i>	3	0.09%
Coreidae	<i>Homoeocerus dilatatus</i>	12	0.35%
Coreidae	<i>Homoeocerus stricornis</i>	3	0.09%
Coreidae	<i>Homoeocerus walkerianus</i>	2	0.06%
Coreidae	<i>Hygia lativentris</i>	13	0.38%
Coreidae	<i>Hygia opaca</i>	2	0.06%
Coreidae	<i>Manocoreus vulgaris</i>	1	0.03%
Coreidae	<i>Mictis tenebrosa</i>	1	0.03%
Coreidae	<i>Molipteryx fuliginosa</i>	3	0.09%
Coreidae	<i>Notobitus montanus</i>	3	0.09%
Coreidae	<i>Ochrochira stenopoda</i>	2	0.06%
Coreidae	<i>Pseudomictis distinctus</i>	1	0.03%
Lygaeidae	<i>Nysius ericae</i>	1414	40.84%
Lygaeidae	<i>Aethalotus nigriventris</i>	6	0.17%
Lygaeidae	<i>Tropidothorax cruciger</i>	13	0.38%
Lygaeidae	<i>Tropidothorax elegans</i>	2	0.06%
Lygaeidae	<i>Pylorgus obscurus</i>	12	0.35%

Family	Scientific Name	Abundance	Relative Abundance (%)
Lygaeidae	<i>Pylorgus porrectus</i>	48	1.39%

The table presents the family name, scientific name, abundance, and relative abundance of the insect group in the Qinling Mountains. Abundance refers to the number of individuals recorded for each species across all sampling sites, and relative abundance refers to the percentage of individuals of each species in the total individuals of the corresponding group.

S3. Supplementary Figures

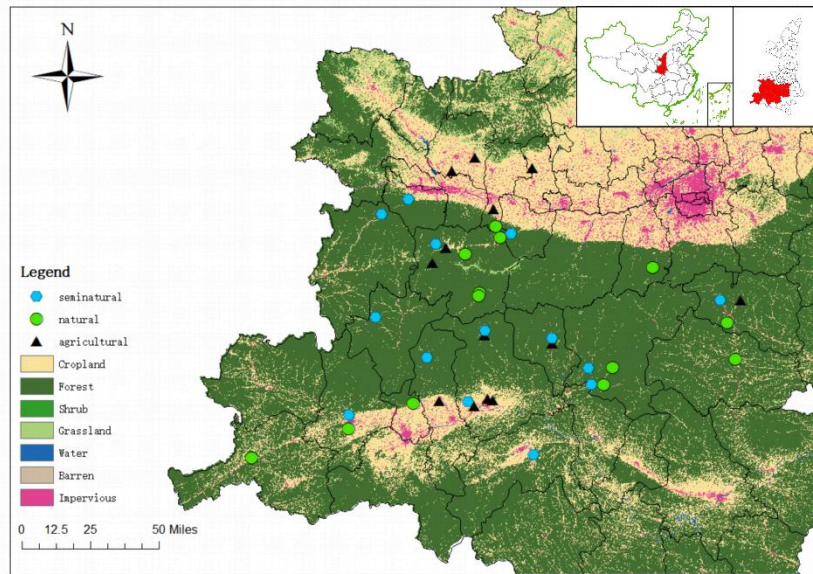


Figure S1 Study area and sampling site distribution in the Qinling Mountains, China. Sampling sites are classified into three habitat types: agricultural, seminatural, and natural. Background colors represent land cover types, including cropland, forest, shrubland, grassland, water, barren land, and impervious surfaces. The inset map shows the location of the study area within China.

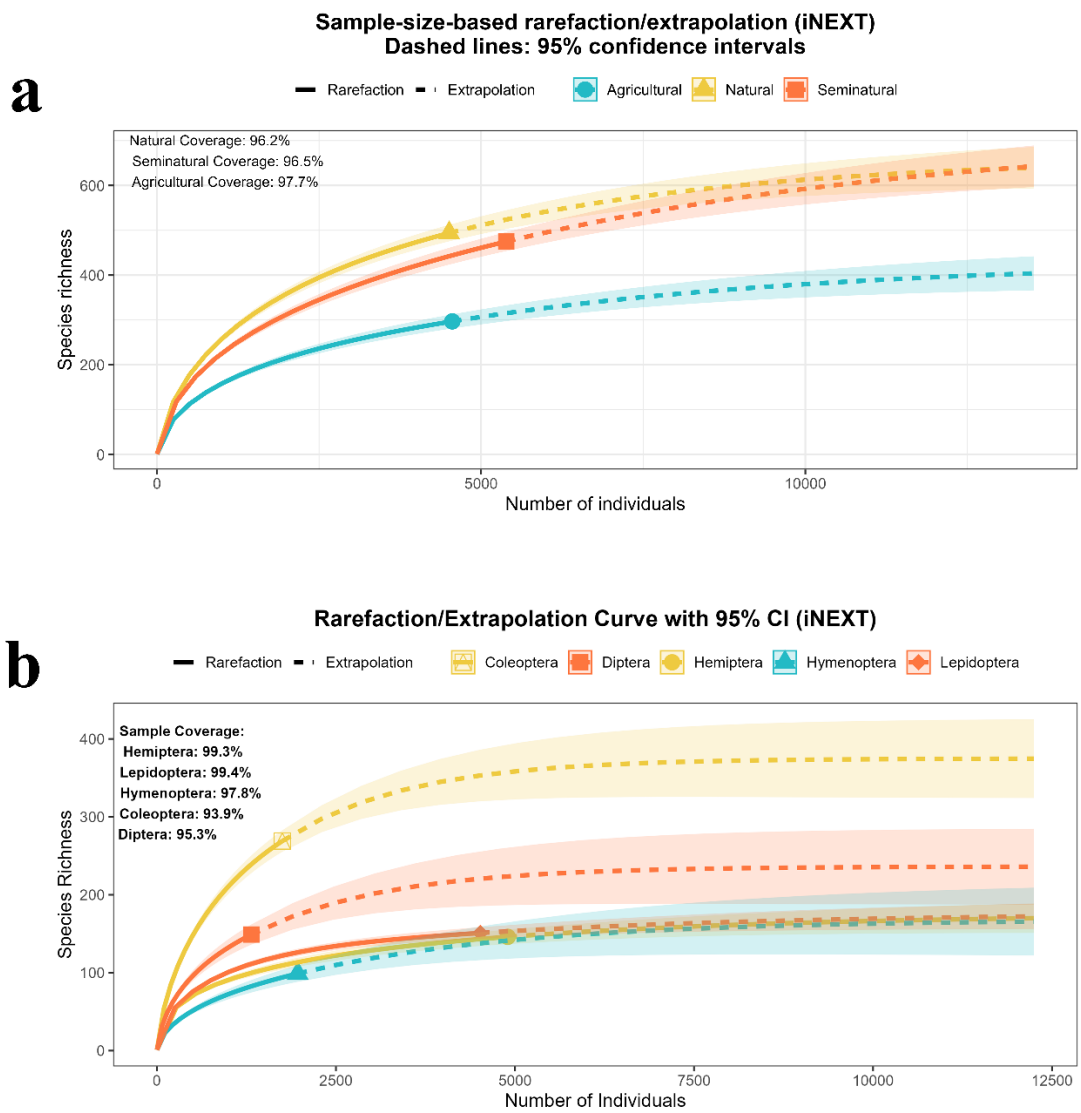


Figure S2 Sample-size-based rarefaction and extrapolation curves of insect species richness. Solid lines represent rarefaction and dashed lines represent extrapolation; shaded areas indicate 95% confidence intervals. (a) Species accumulation curves across three habitat types (agricultural, semi-natural, and natural). Points indicate observed sample sizes, and sample coverage values are provided for each habitat. (b) Species accumulation curves across five taxonomic groups (Coleoptera, Diptera, Hemiptera, Hymenoptera, and Lepidoptera). Sample coverage values are shown for each group.

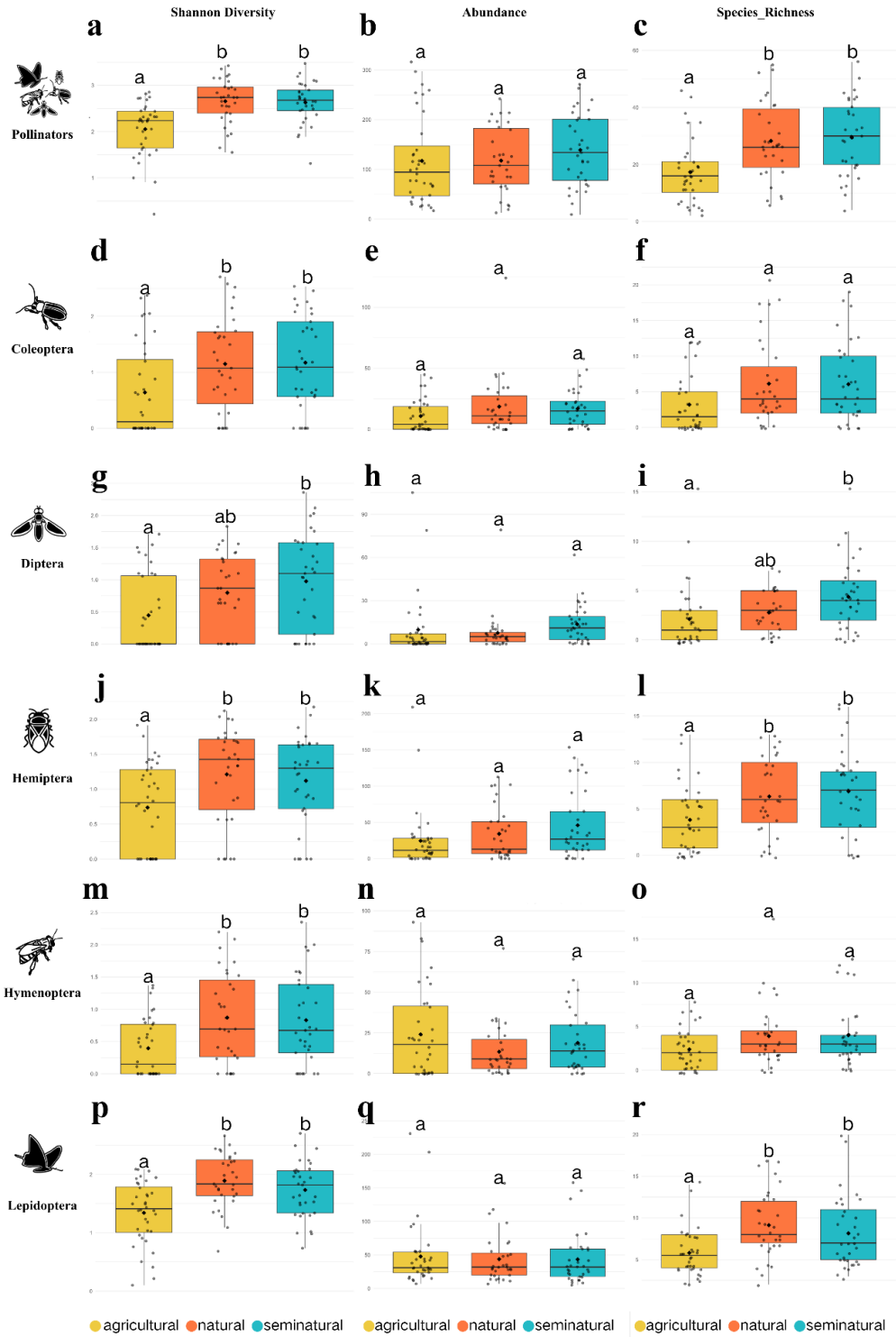


Figure S3 Variation in diversity metrics of pollinators and major taxa across habitat types. Panels show Shannon diversity (a, d, g, j, m, p), abundance (b, e, h, k, n, q), and species richness (c, f, i, l, o, r) for pollinators and major insect orders (Coleoptera, Diptera, Hemiptera, Hymenoptera, and Lepidoptera) across agricultural, natural, and seminatural habitats. Letters indicate (a, b, ab) significant differences among habitat types, ($P < 0.05$). Black insect icons denote the corresponding taxonomic group.

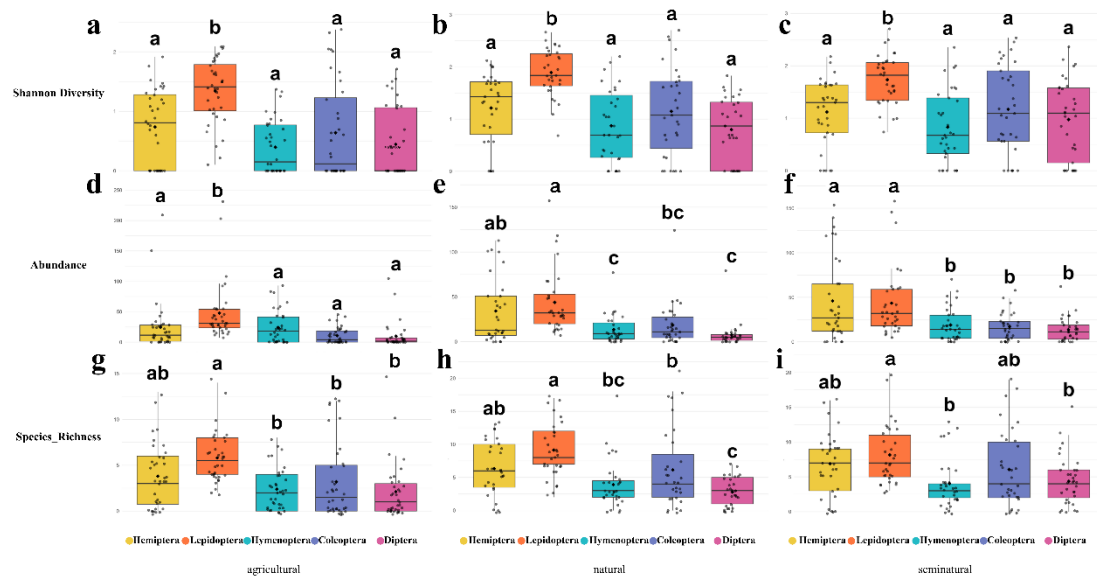


Figure S4 Variation in diversity metrics of pollinator taxa across different habitat types. Boxplots show Shannon diversity (a–c), abundance (d–f), and species richness (g–i) of five pollinator taxa (Hemiptera, Lepidoptera, Hymenoptera, Coleoptera, and Diptera) across agricultural, natural, and seminatural habitats. Each column represents a habitat type. Different letters (a, b, ab, c) above boxplots indicate significant differences among taxa within each habitat ($P < 0.05$). Points represent individual sampling sites.

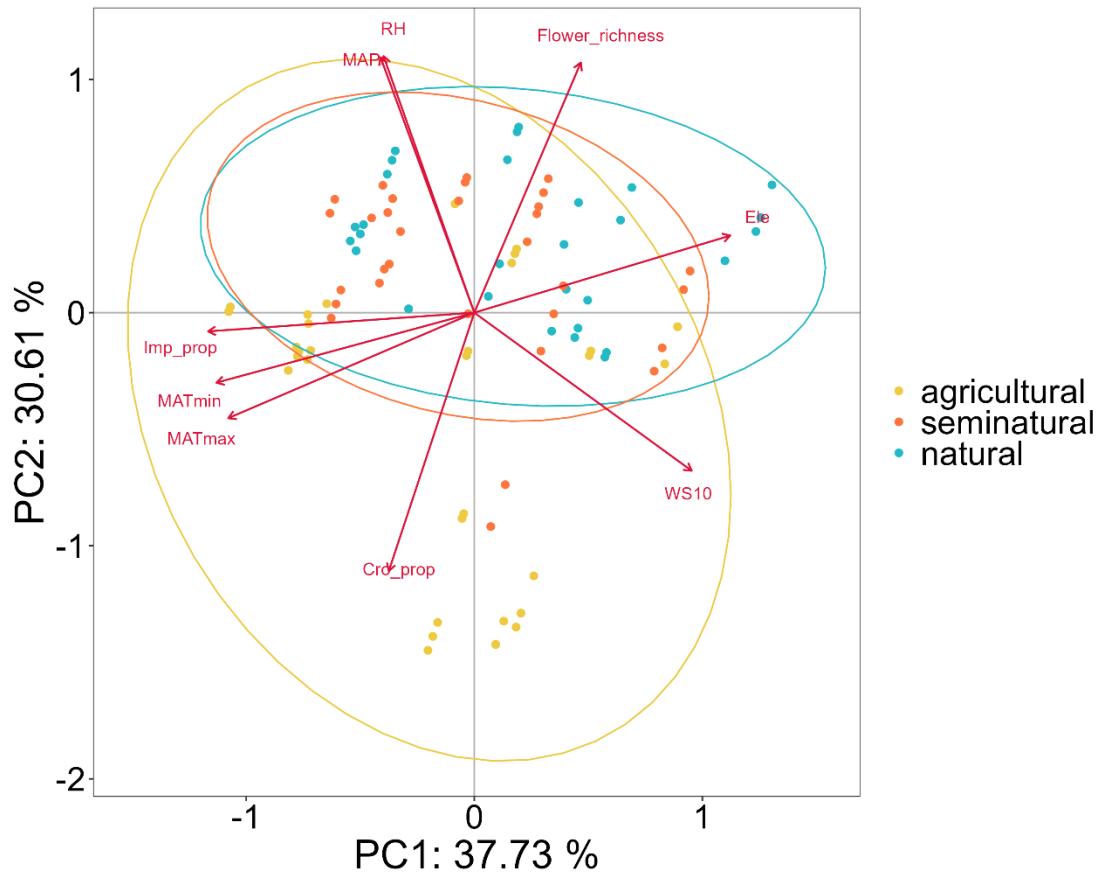


Figure S5 Principal component analysis (PCA) of environmental variables across sampling sites. Points represent sampling sites colored by habitat type. Arrows indicate environmental variables, with arrow length representing the strength of their contribution to environmental variation and direction indicating gradients. Ellipses represent 95% confidence intervals for each habitat type.

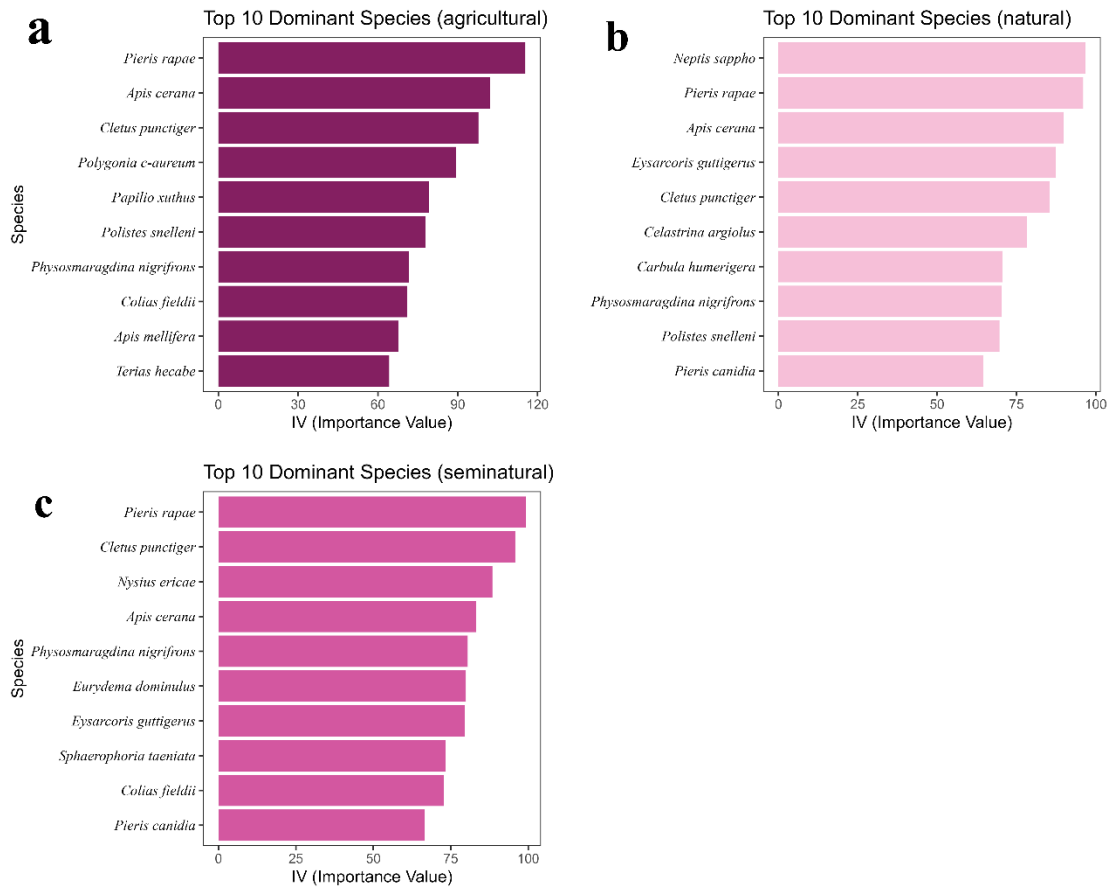


Figure S6 Ranking of dominant pollinating insect species by importance value (IV) across different habitats. Panel(a)show the agricultural habitat, panel b the natural habitat, and panel c the seminatural habitat. The x-axis represents the importance value of each species, and the y-axis lists species names, showing the top 10 dominant pollinating insect species in each habitat.

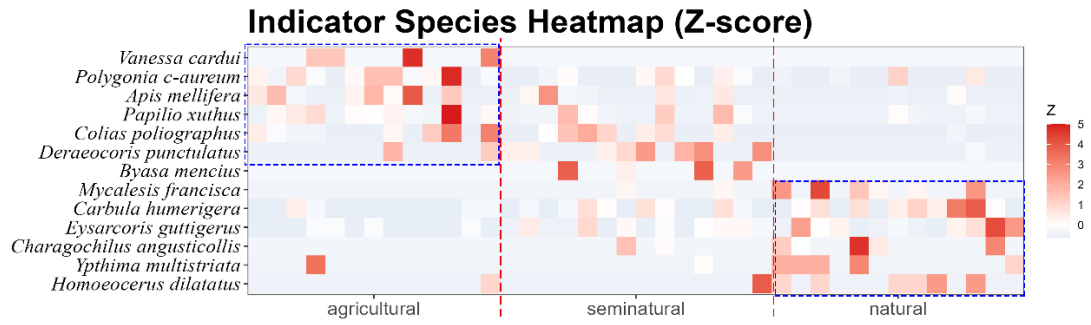


Figure S7 Pollinator Heatmap of indicator species across different habitats (Z-score standardized abundance). Rows represent species and columns represent sampling sites grouped by habitat (agricultural, semi-natural, and natural). Warmer colors indicate higher relative abundance. Dashed boxes highlight habitat-specific clusters of indicator species. Species names are shown in italics.

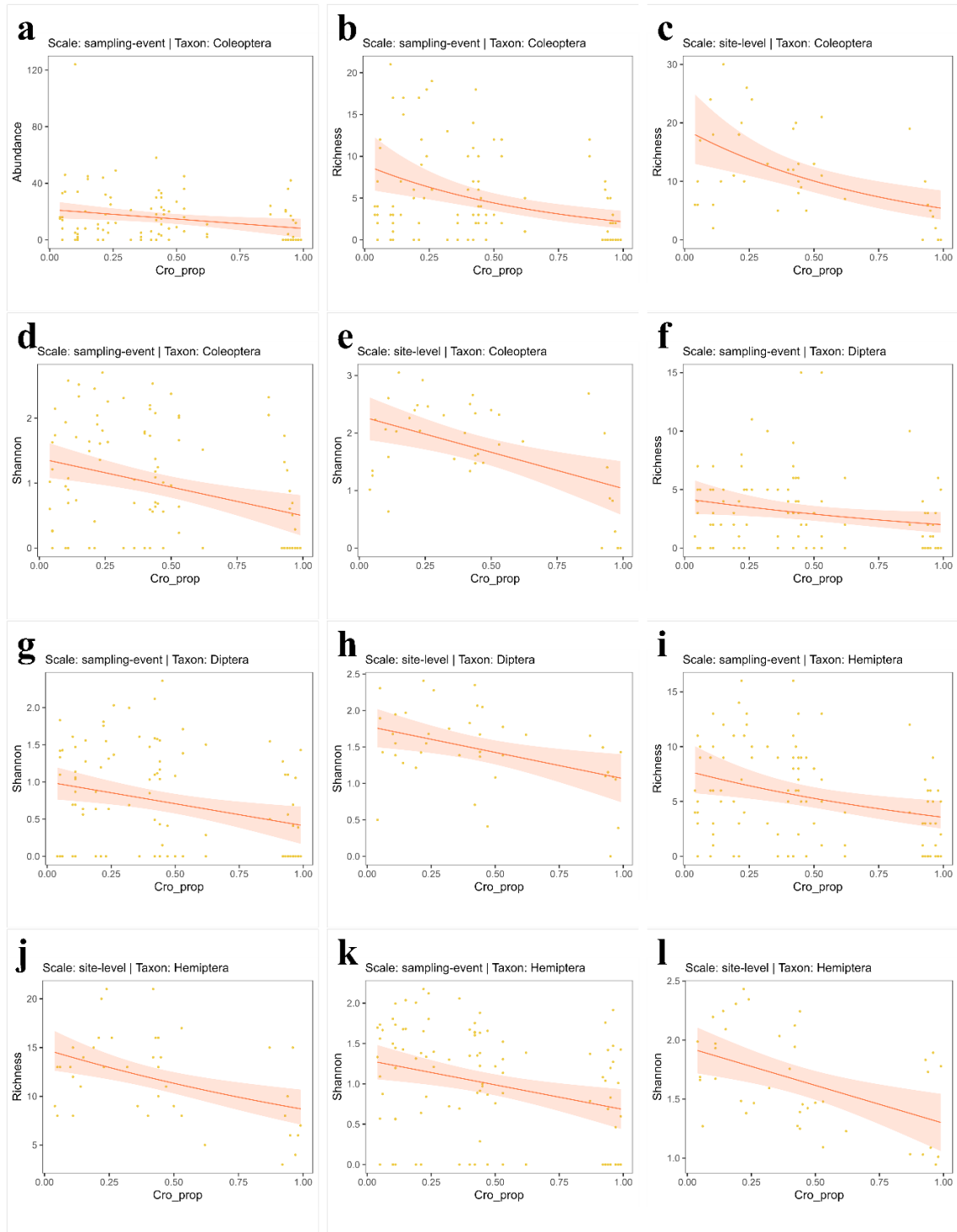


Figure S8a Effects of environmental factors on the diversity of the overall pollinating insect community. Panels show relationships between environmental variables (MATmax, MATmin, MAT, forest proportion (For_prop), cropland proportion (Cro_prop), elevation (Ele), wind speed (WS10), precipitation (MAP), relative humidity (RH), and flower_richness) and diversity metrics (species richness, Shannon diversity, and abundance). Points represent observations, lines indicate model

predictions, and shaded areas represent 95% confidence intervals. Black insect icons indicate the focal pollinator taxonomic group represented in each panel. Only statistically significant relationships ($P \leq 0.05$) are presented in all panels.

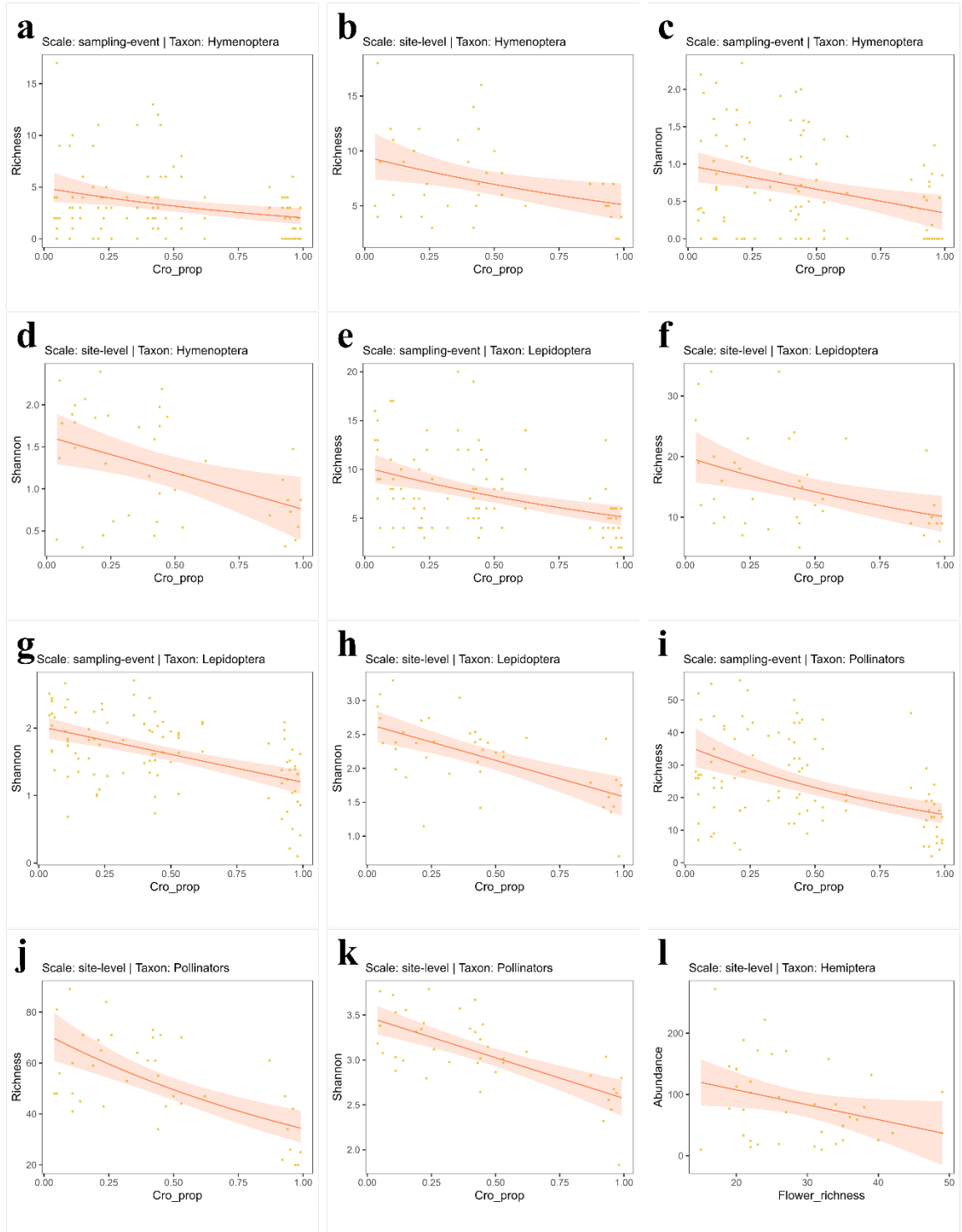


Figure S8b

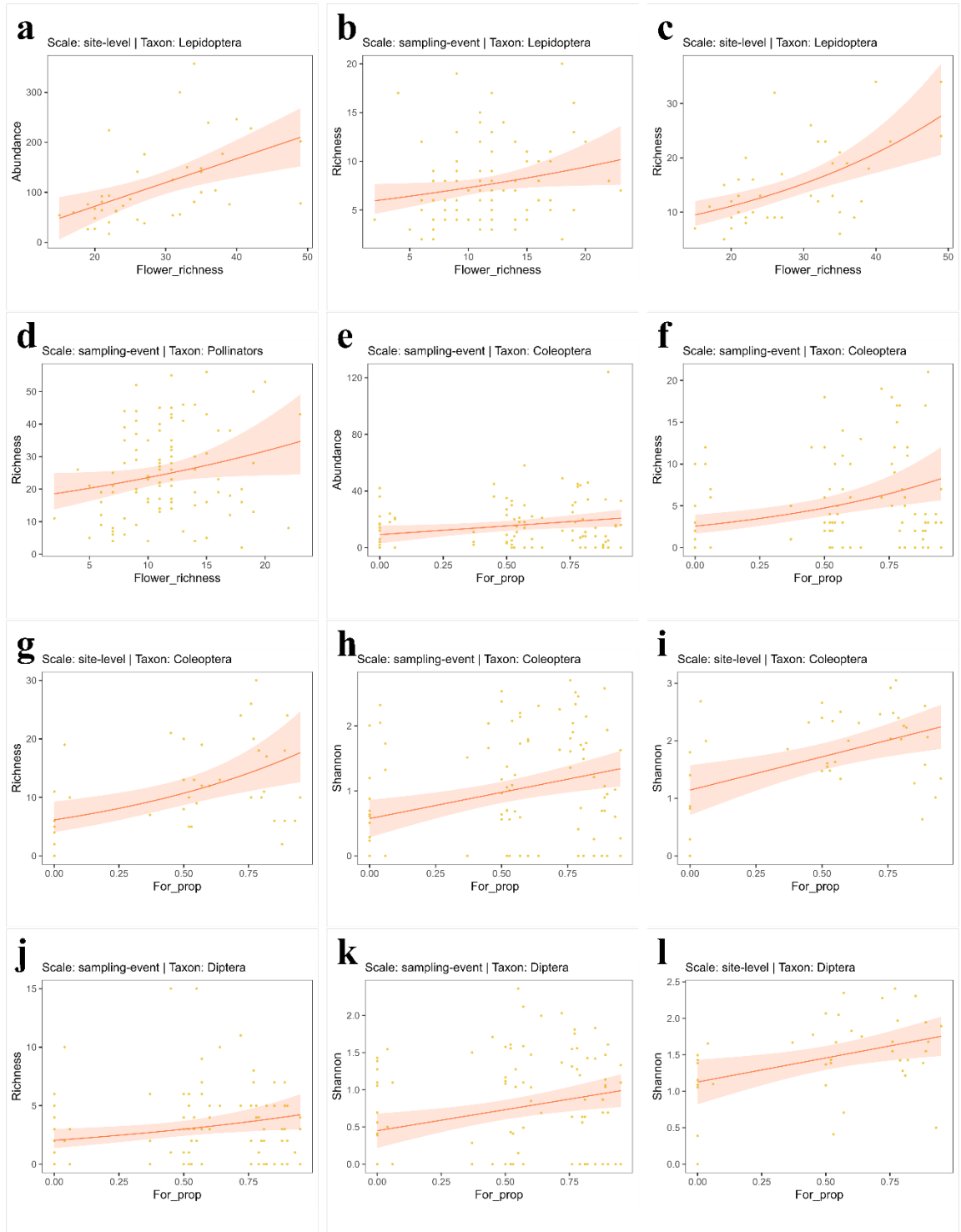


Figure S8c

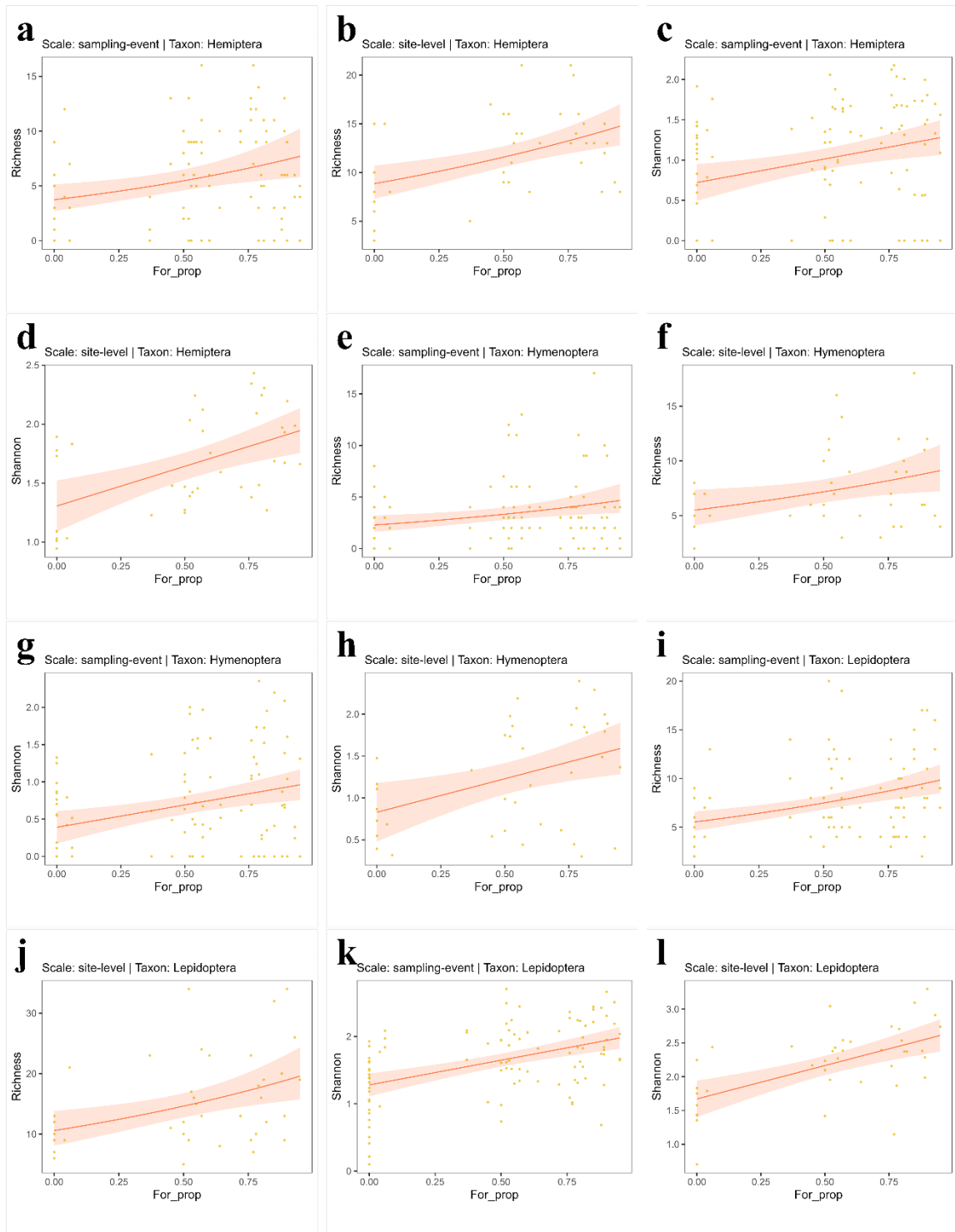


Figure S8d

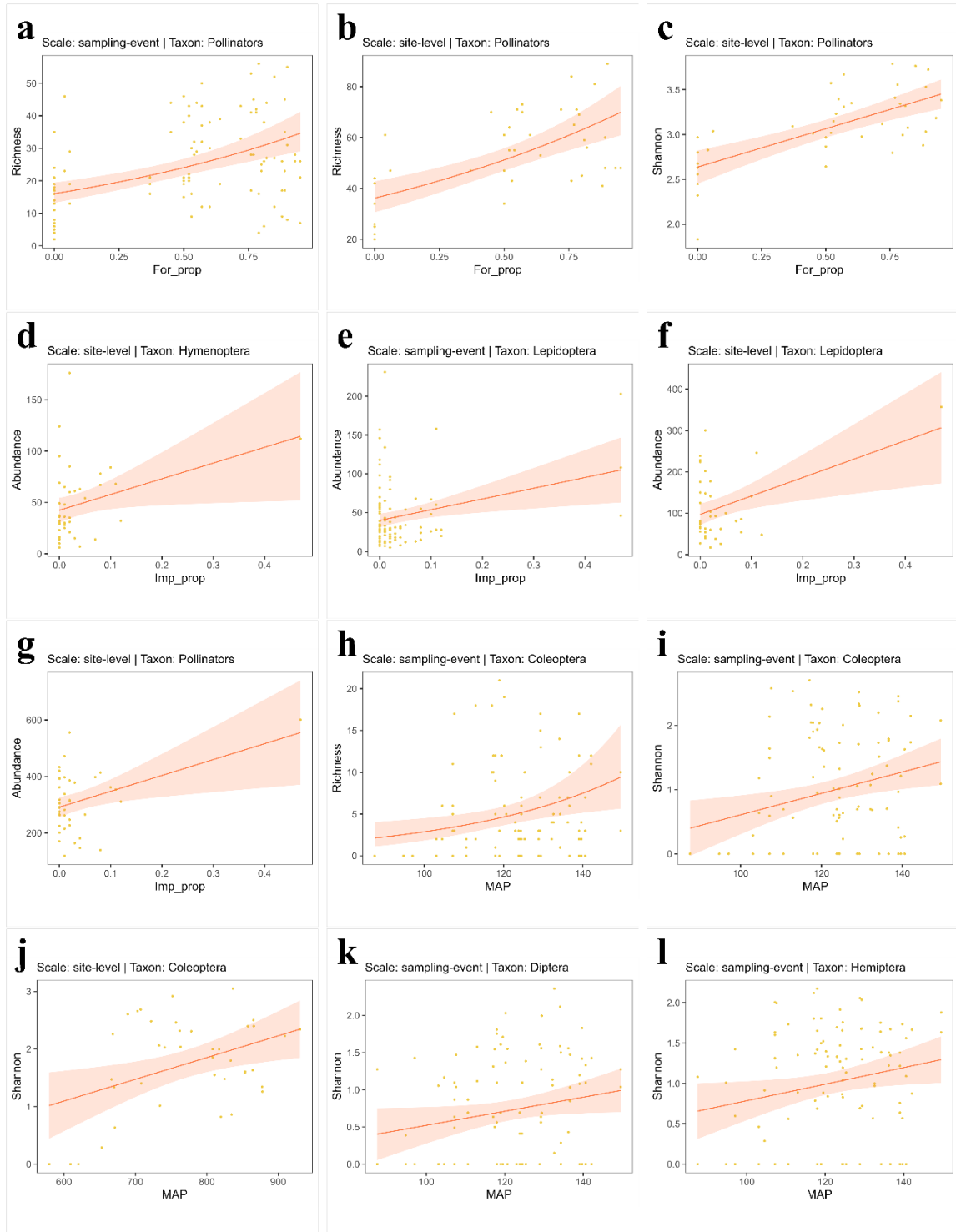


Figure S8e

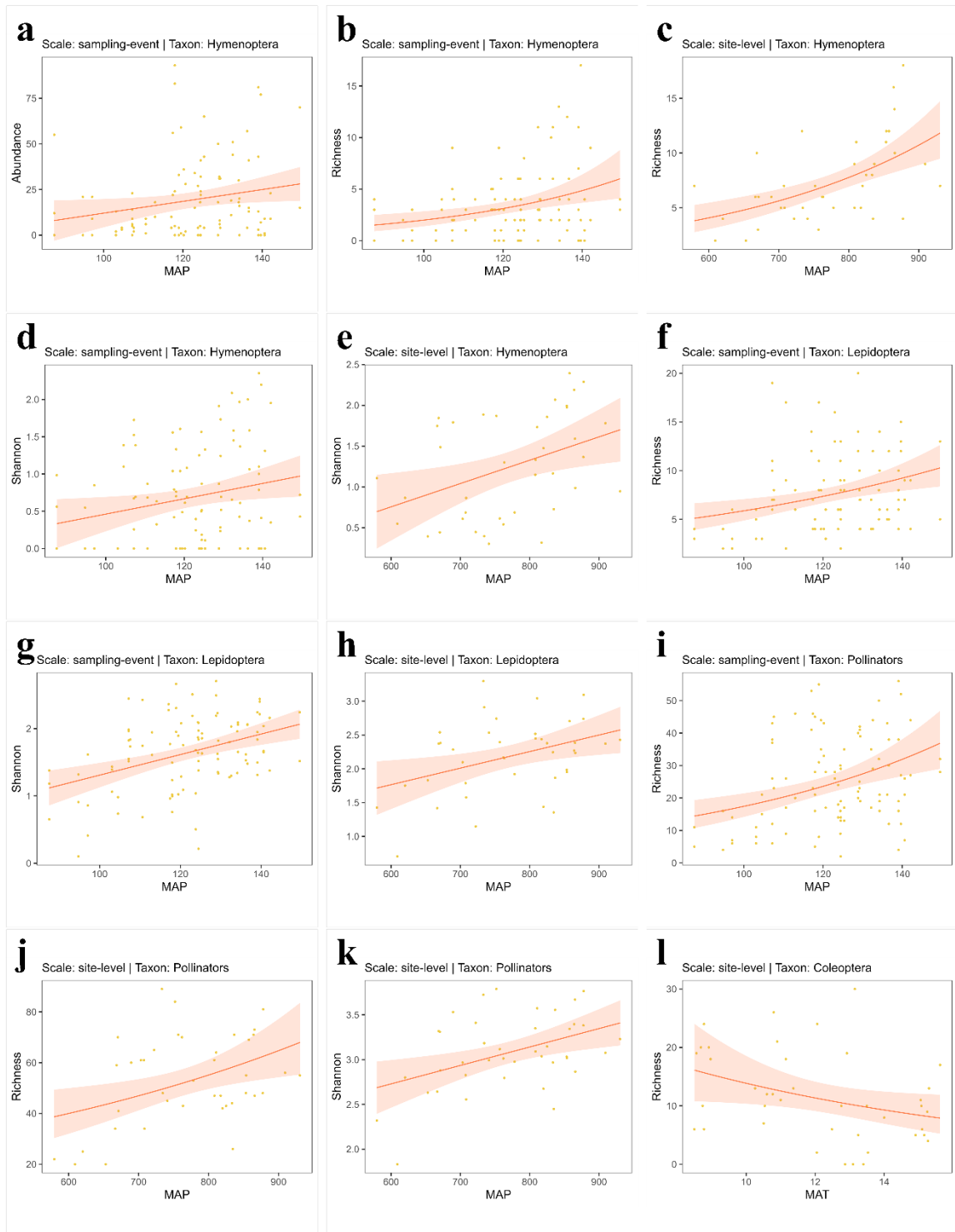


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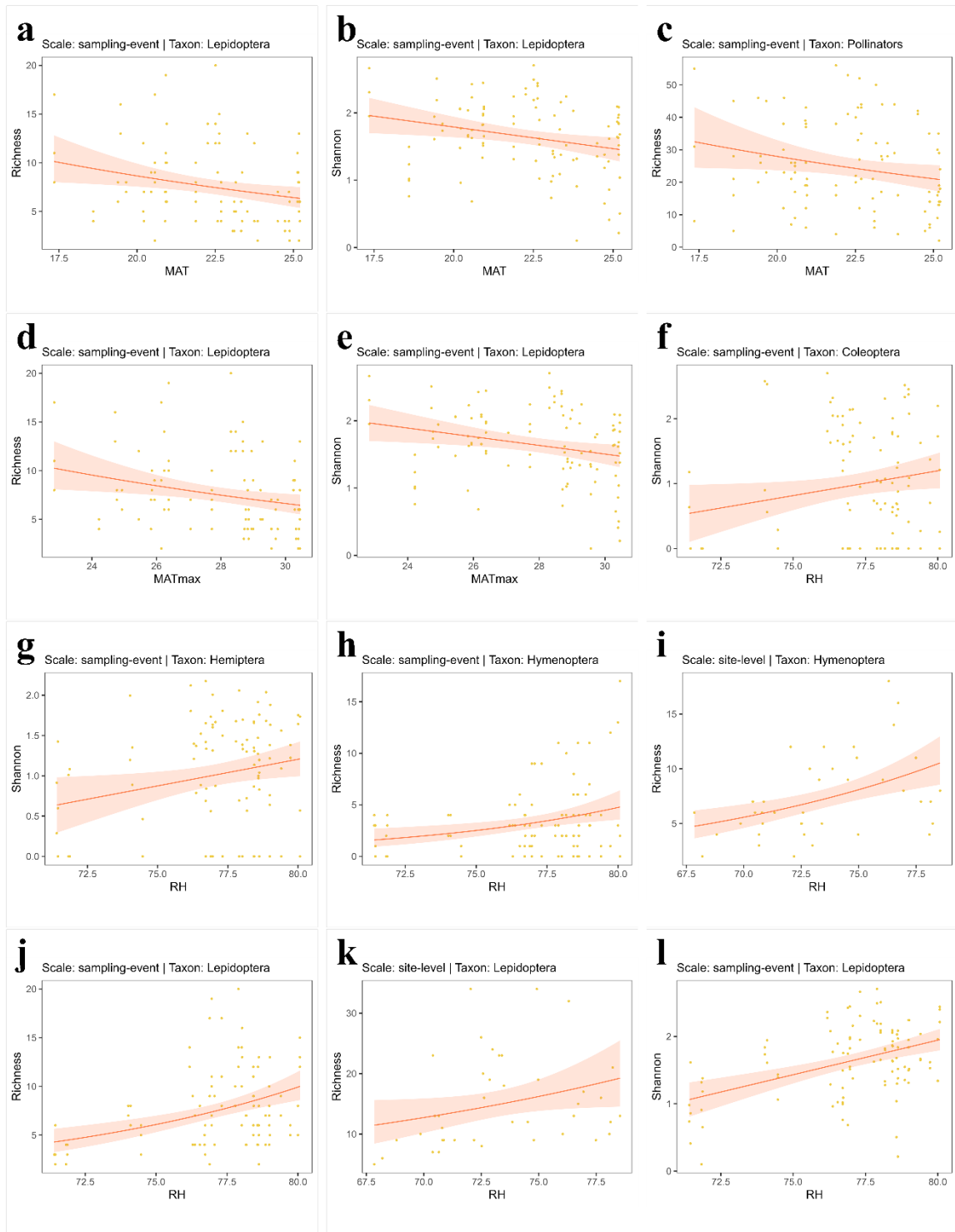


Figure S8g

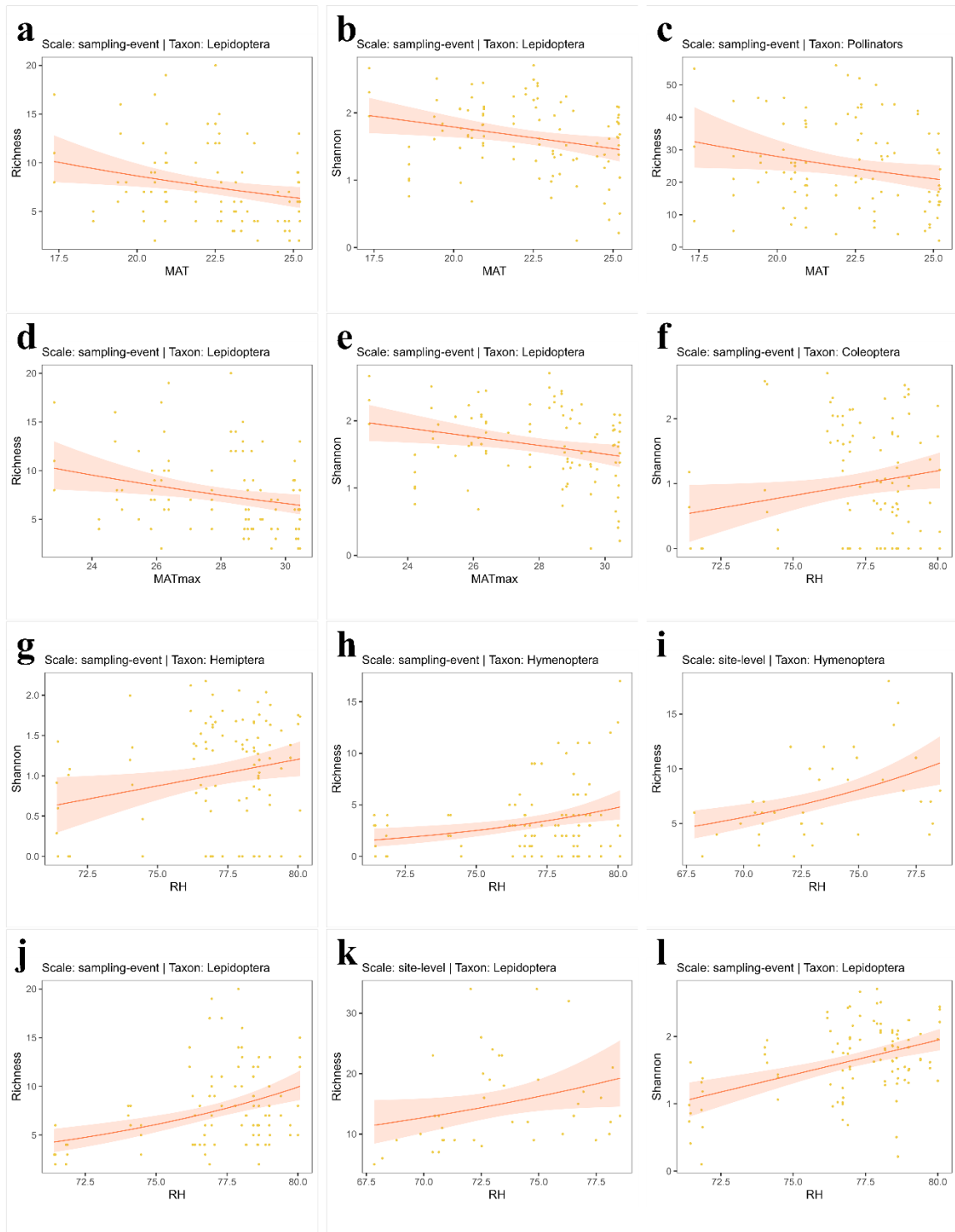


Figure S8h

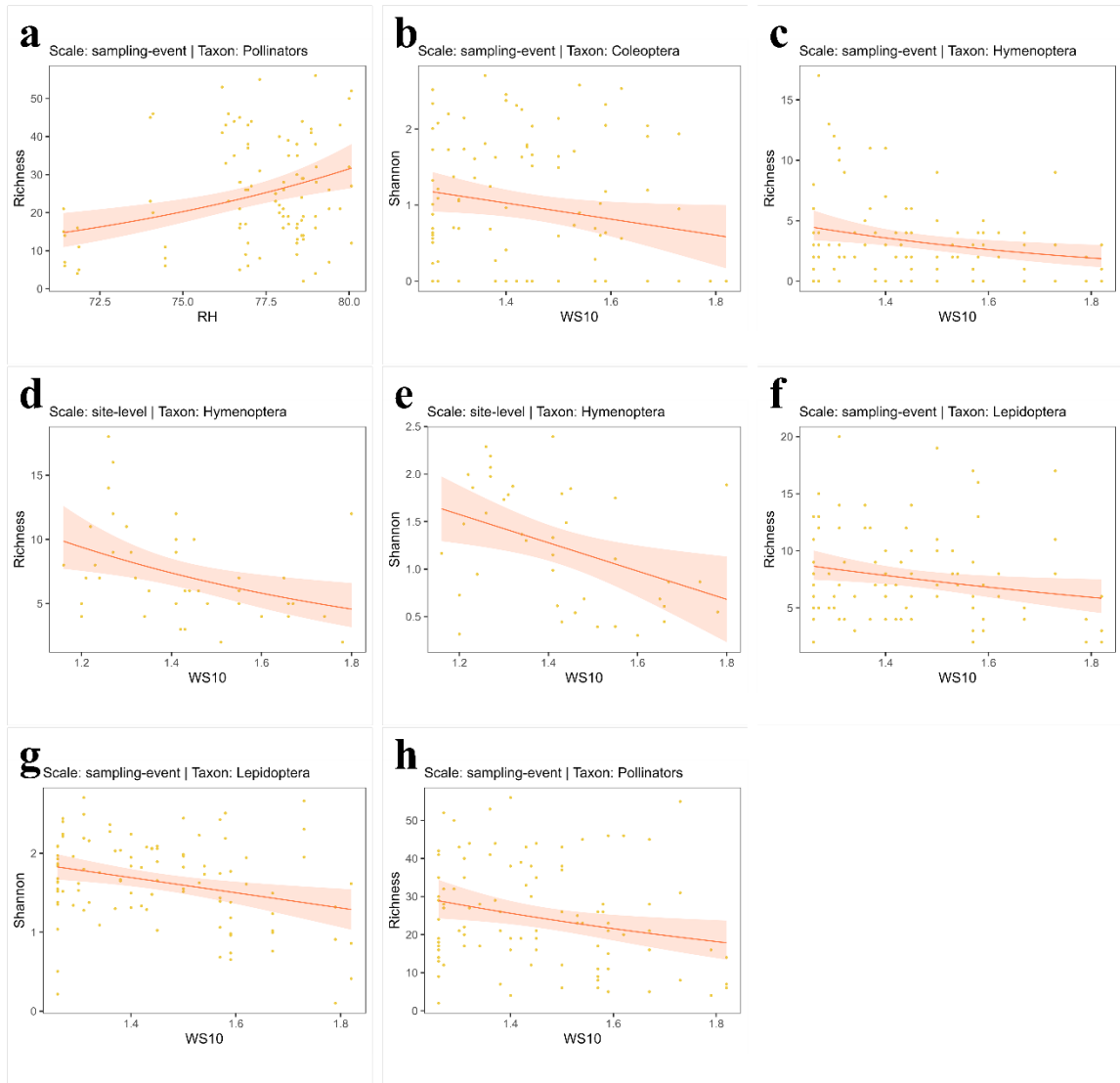


Figure S8i

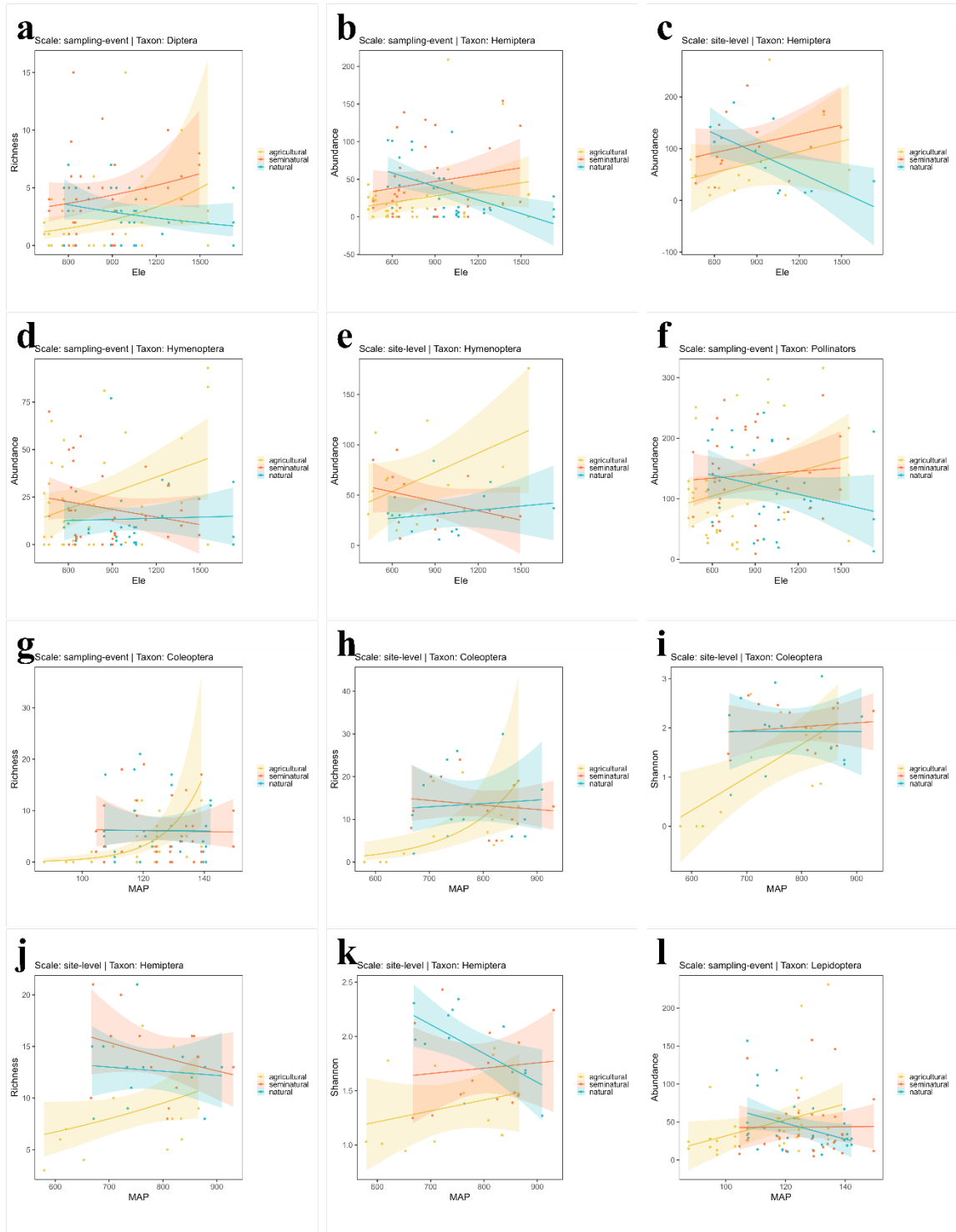


Figure S9a Differential effects of climatic factors on pollinator communities across habitat types. Panels show relationships between environmental variables (MATmax, MATmin, MAT, forest proportion (For_prop), cropland proportion (Cro_prop), elevation (Ele), wind speed (WS10), precipitation (MAP), relative humidity (RH), and flower_richness) and diversity metrics (species richness, Shannon diversity, and abundance) under different habitat types (agricultural, seminatural,

and natural). Lines represent model predictions for each habitat, and shaded areas indicate 95% confidence intervals. Black insect icons indicate the focal pollinator taxonomic group represented in each panel. Only statistically significant relationships ($P \leq 0.05$) are presented in all panels.

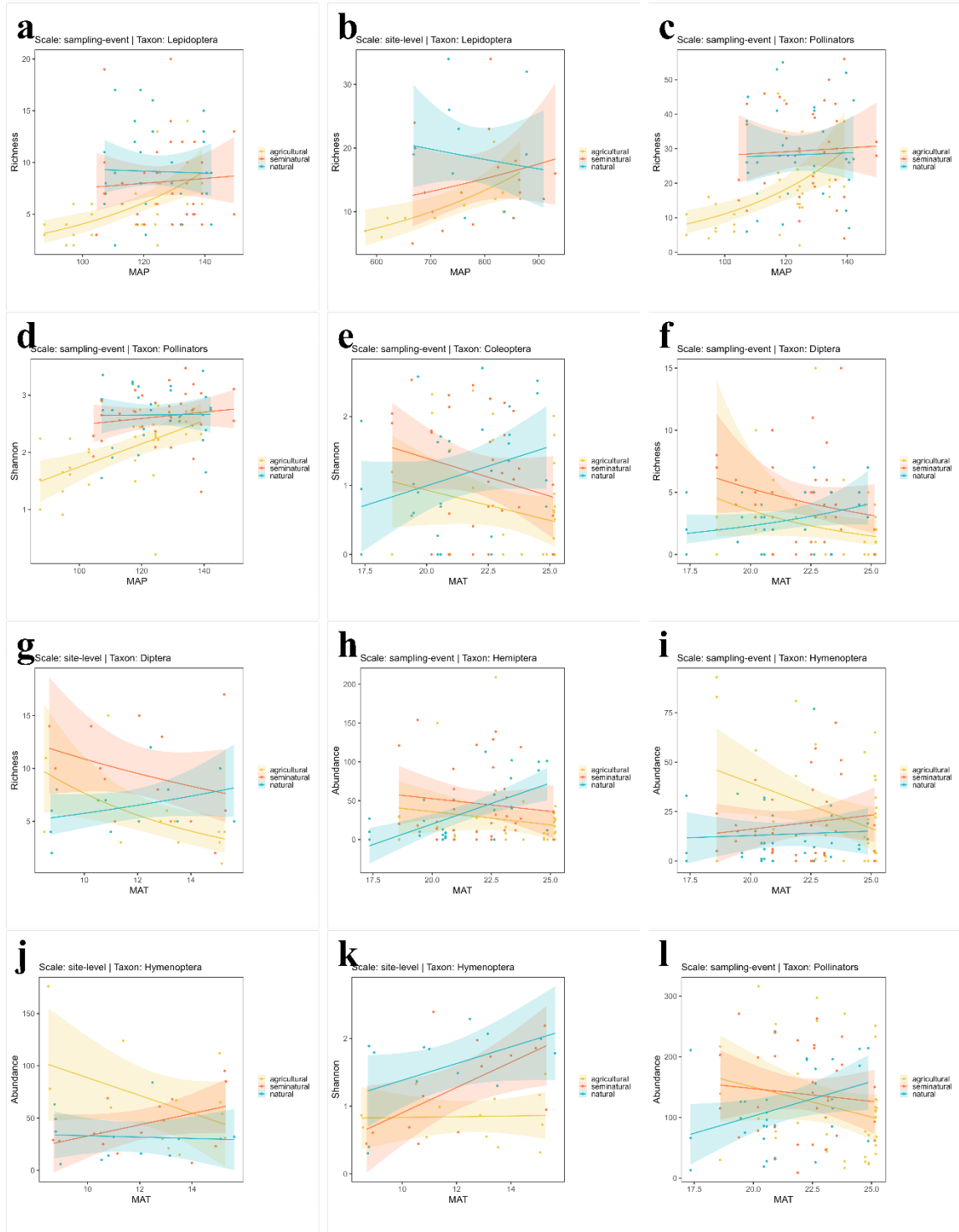


Figure S9b

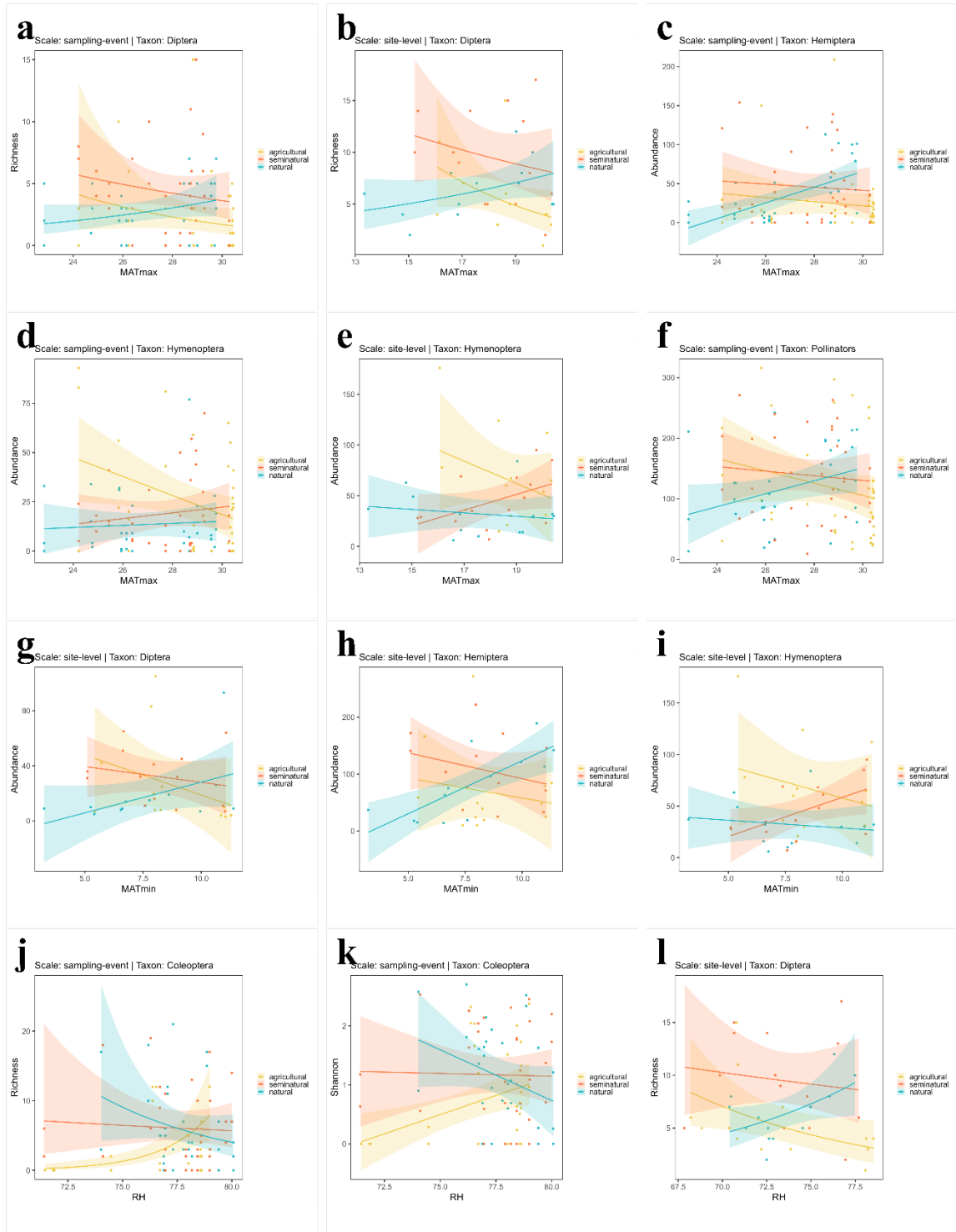


Figure S9c

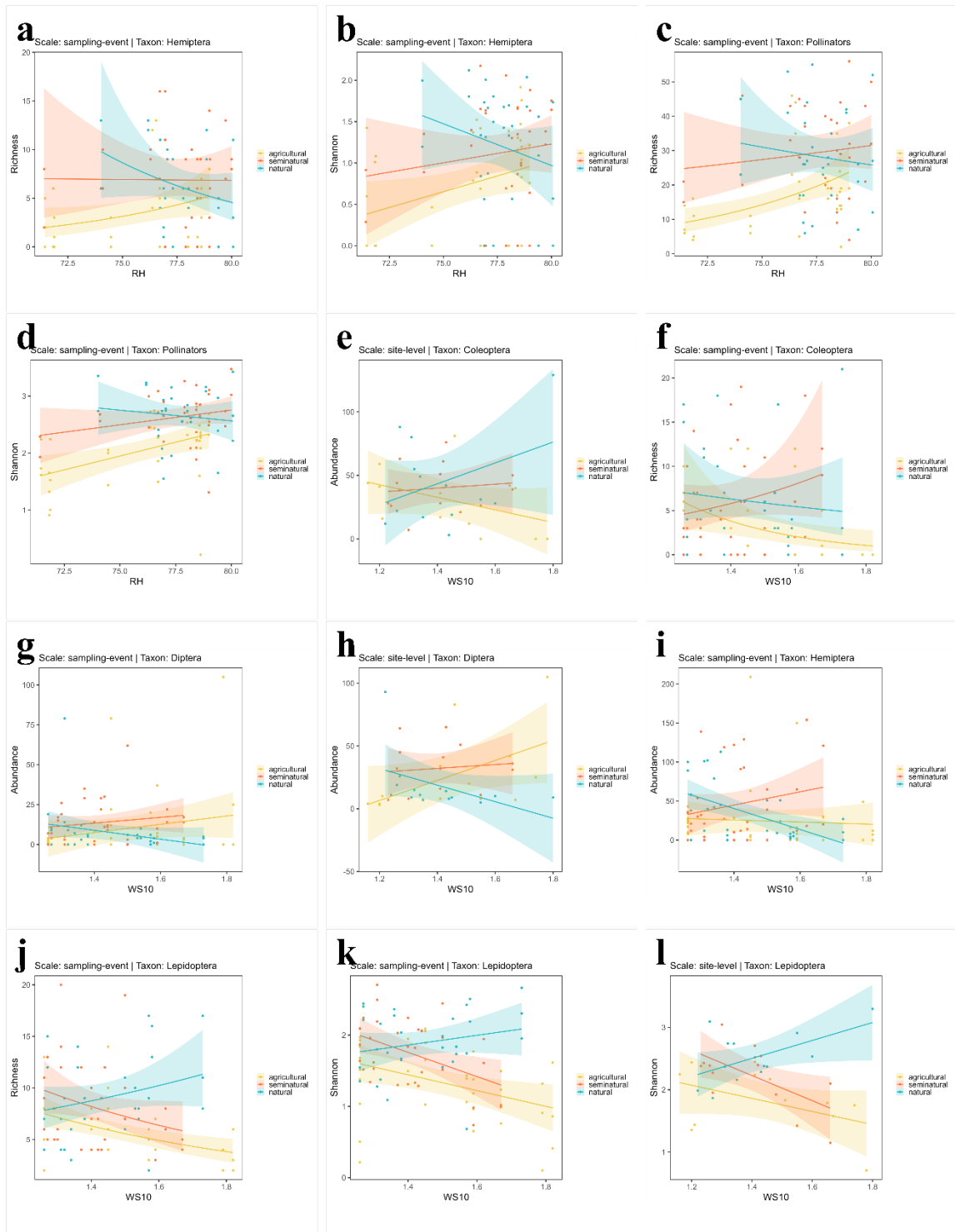


Figure S9d

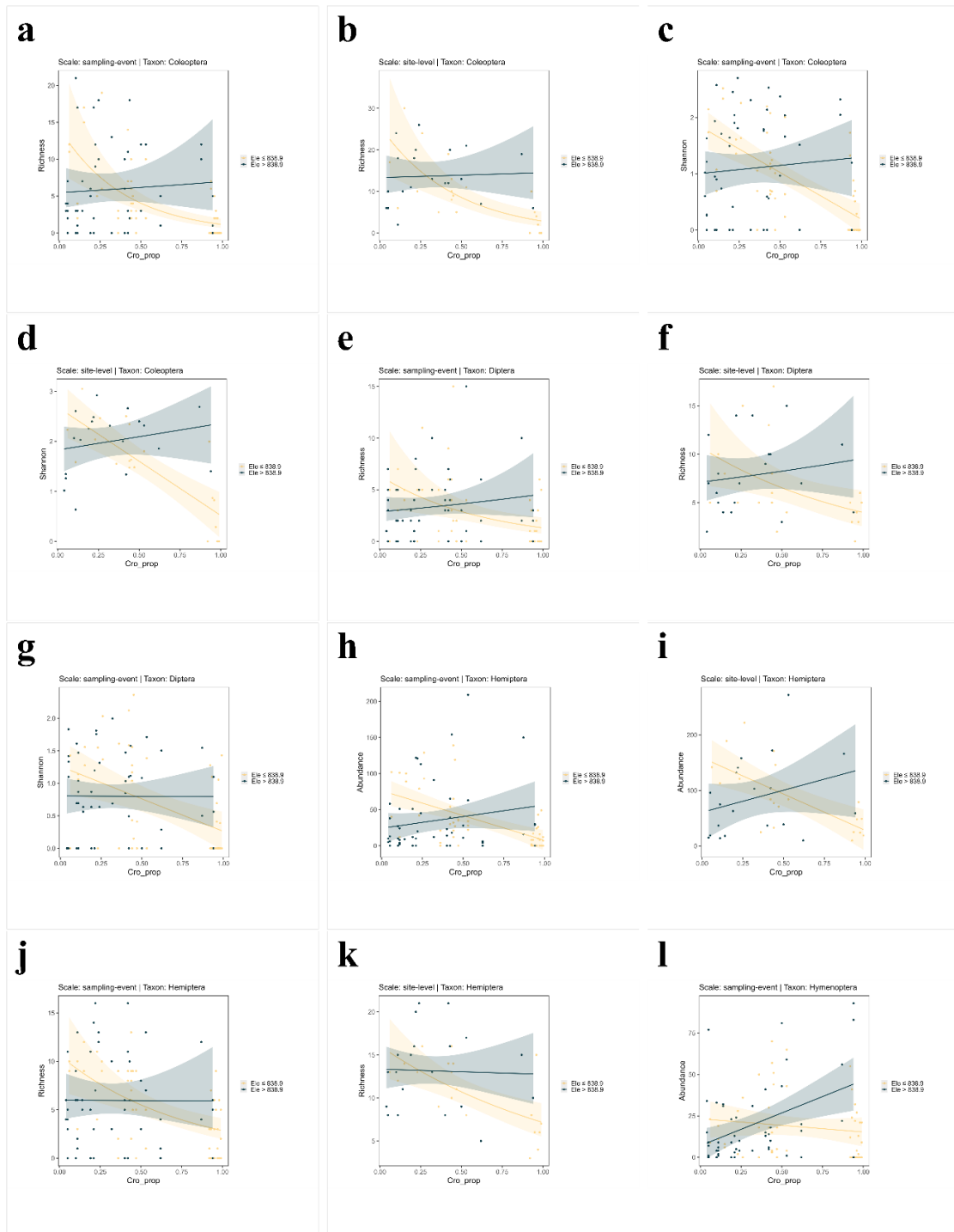


Figure S10a Interaction effects between environmental variables on pollinator community diversity under binary grouping conditions. Each panel shows the relationship between a continuous environmental variable (x-axis) and a diversity metric (species richness, Shannon diversity, or abundance), with data grouped by a second environmental variable divided into two levels (e.g., low vs. high). Points represent observations, solid lines indicate model predictions, and shaded areas represent 95% confidence intervals. Differences in slopes between the two groups reflect the

interaction effect between the grouping variable and the continuous predictor. Panels (a–l) represent different combinations of pollinator taxa, diversity metrics, and environmental variables (see axis labels for details). Black insect icons indicate the focal pollinator taxonomic group represented in each panel. Grouping thresholds are indicated in the legends of each panel. Only statistically significant relationships ($P \leq 0.05$) are presented in all panels.

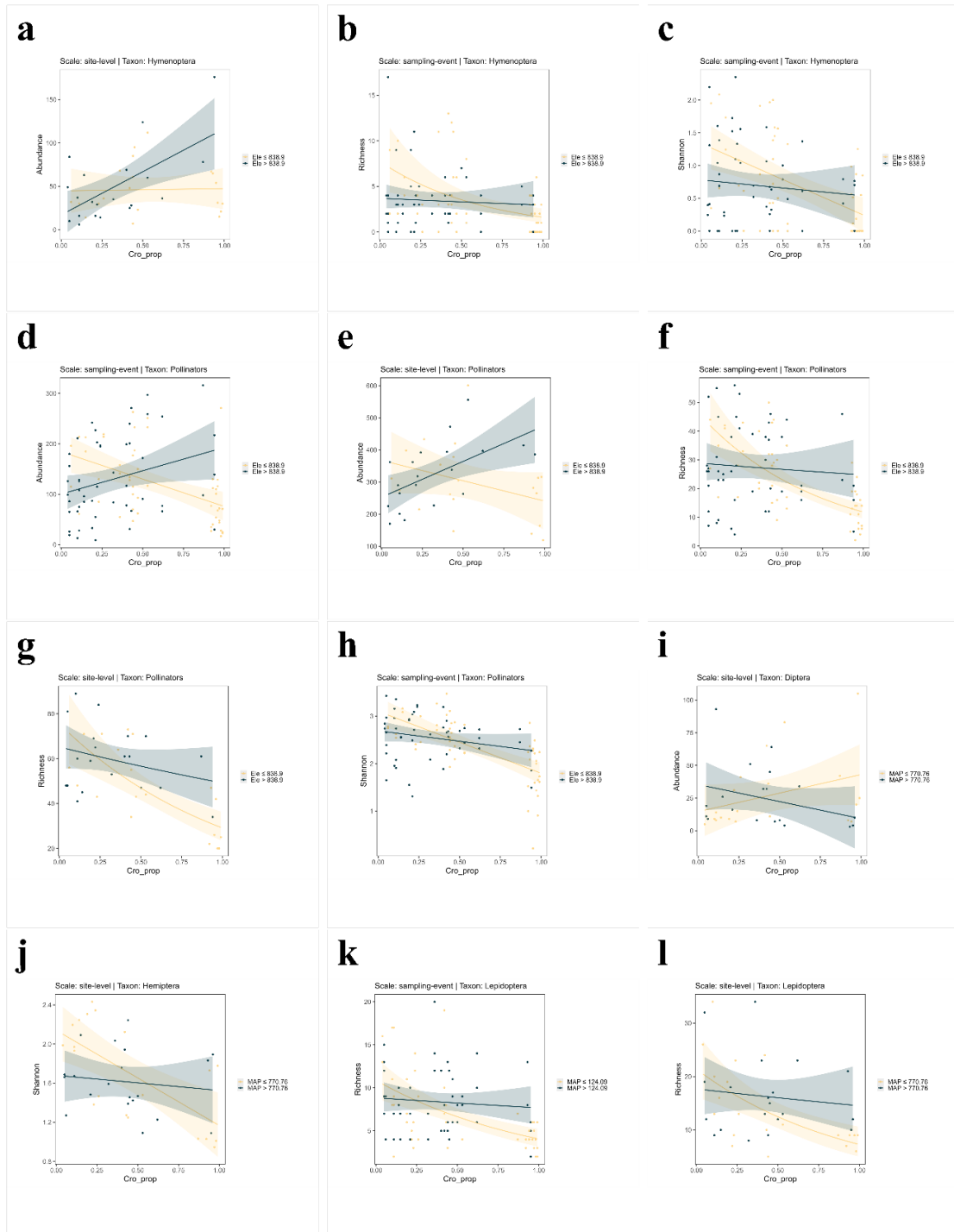


Figure S10b

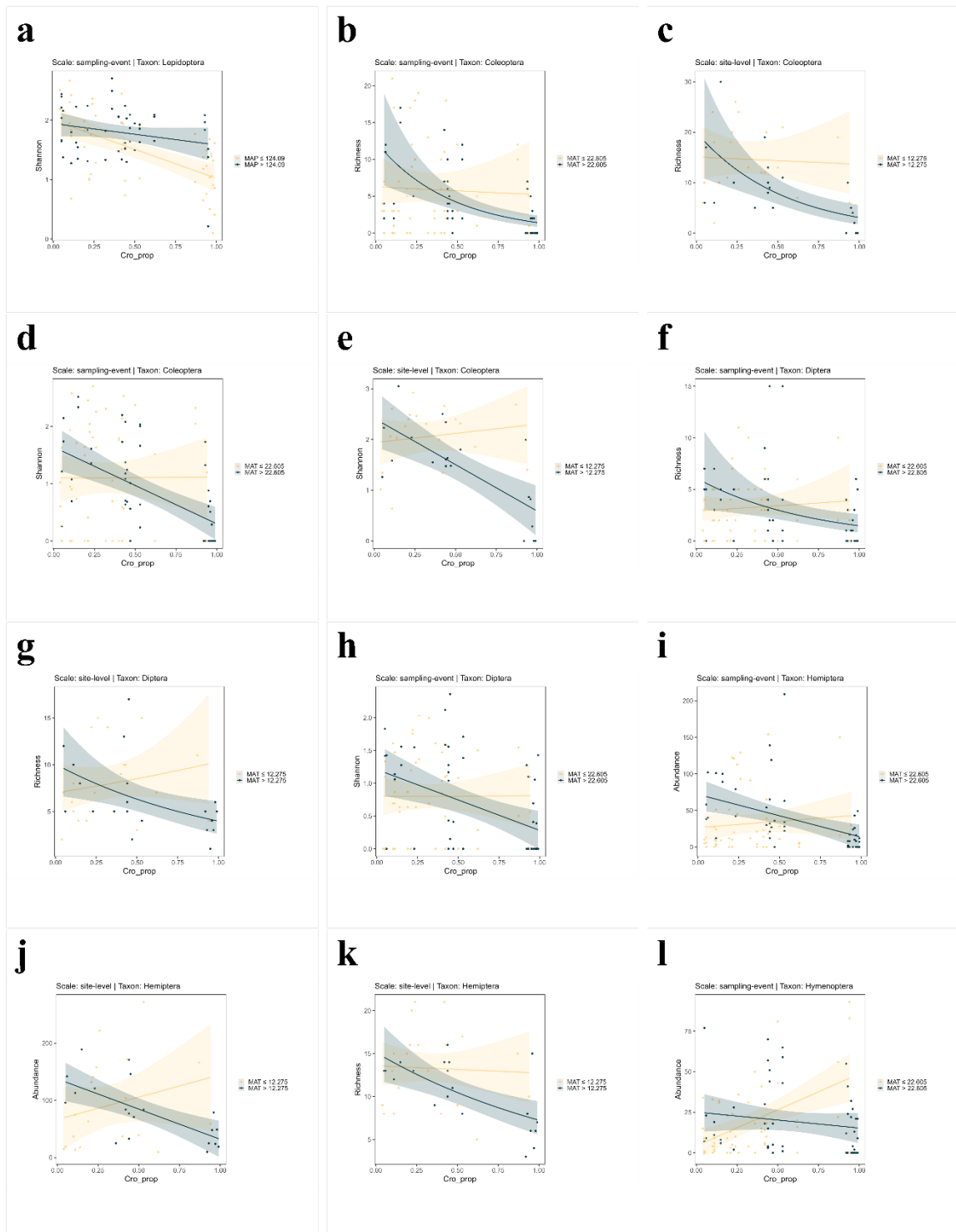


Figure S10c

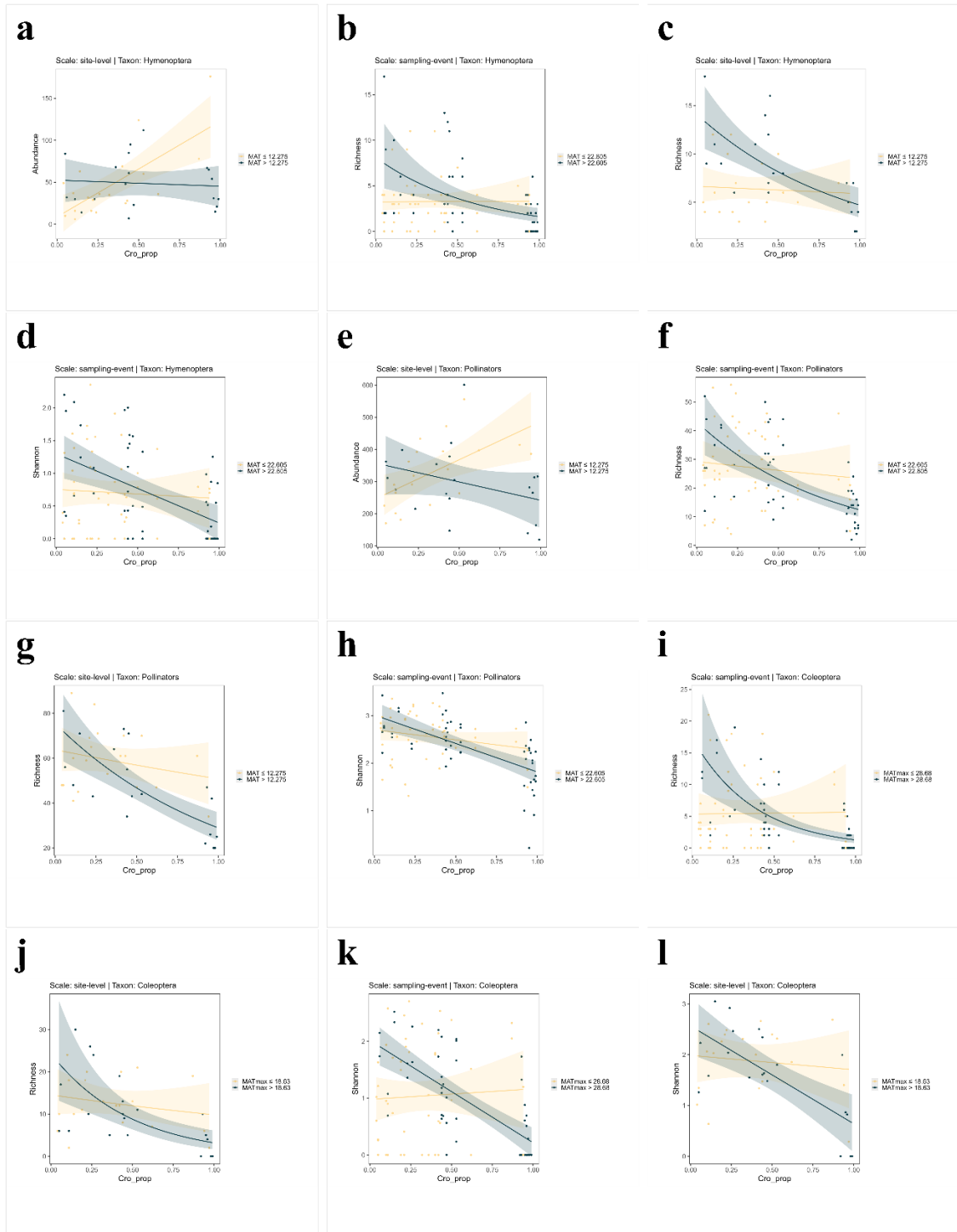


Figure S10d

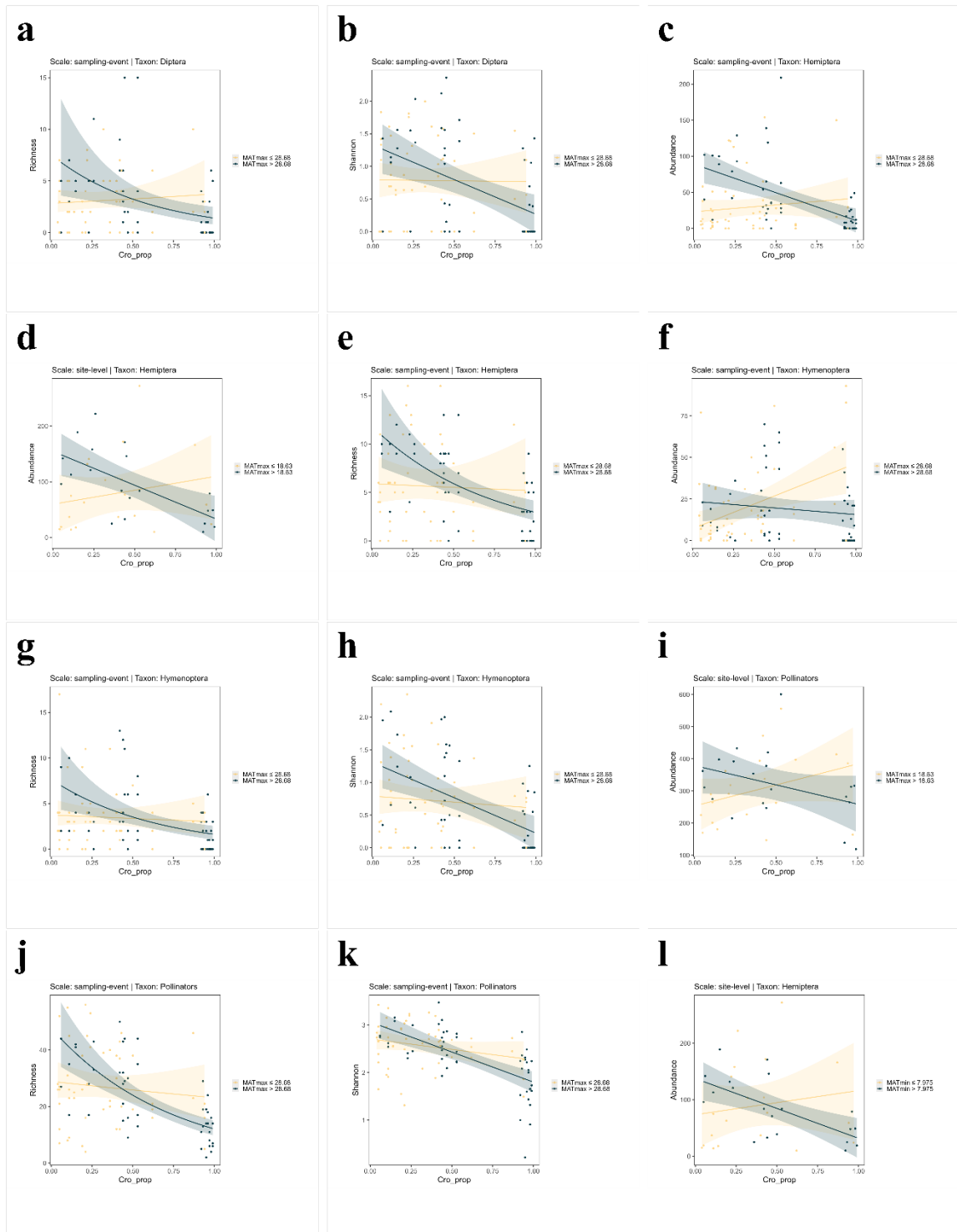


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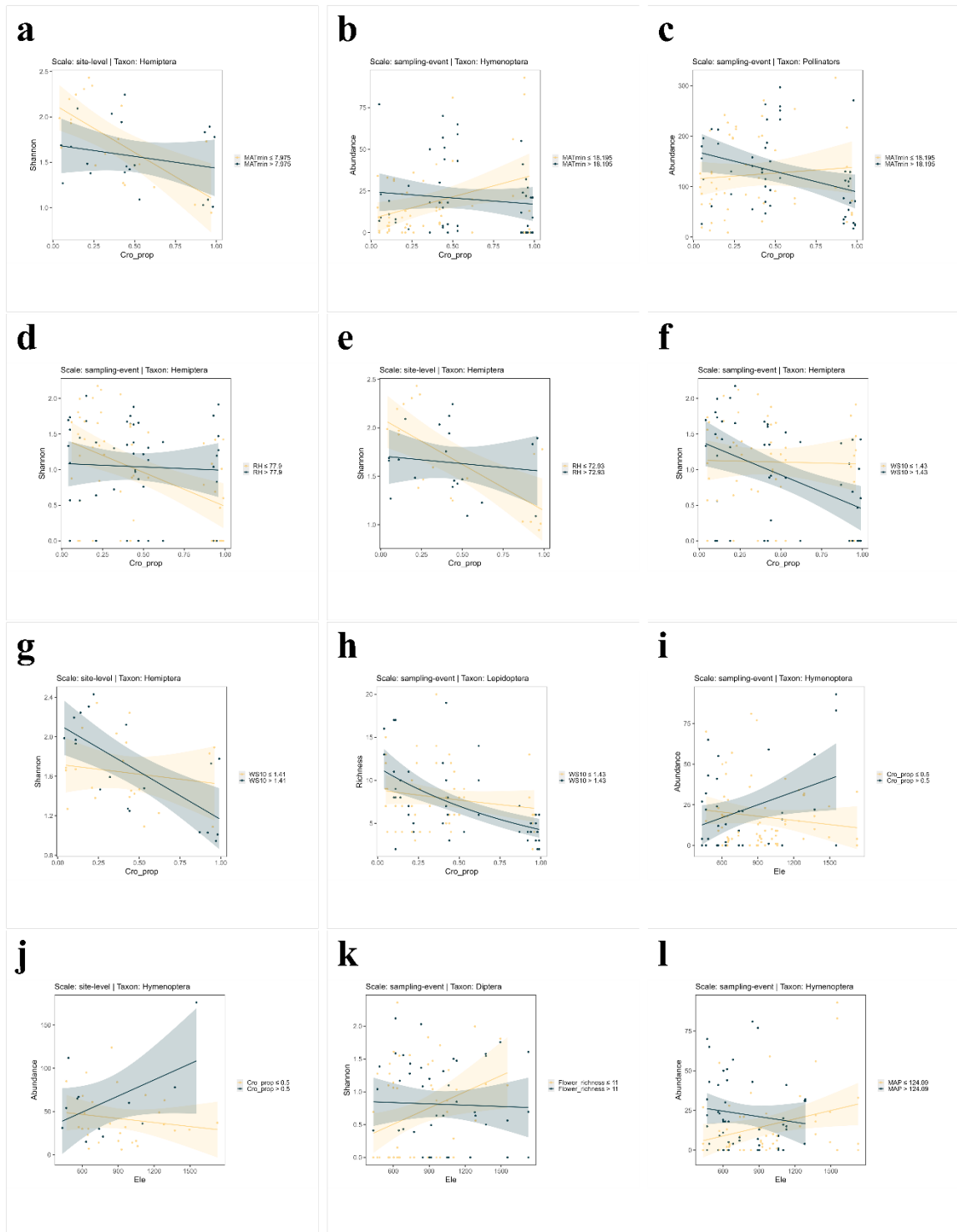


Figure S10f

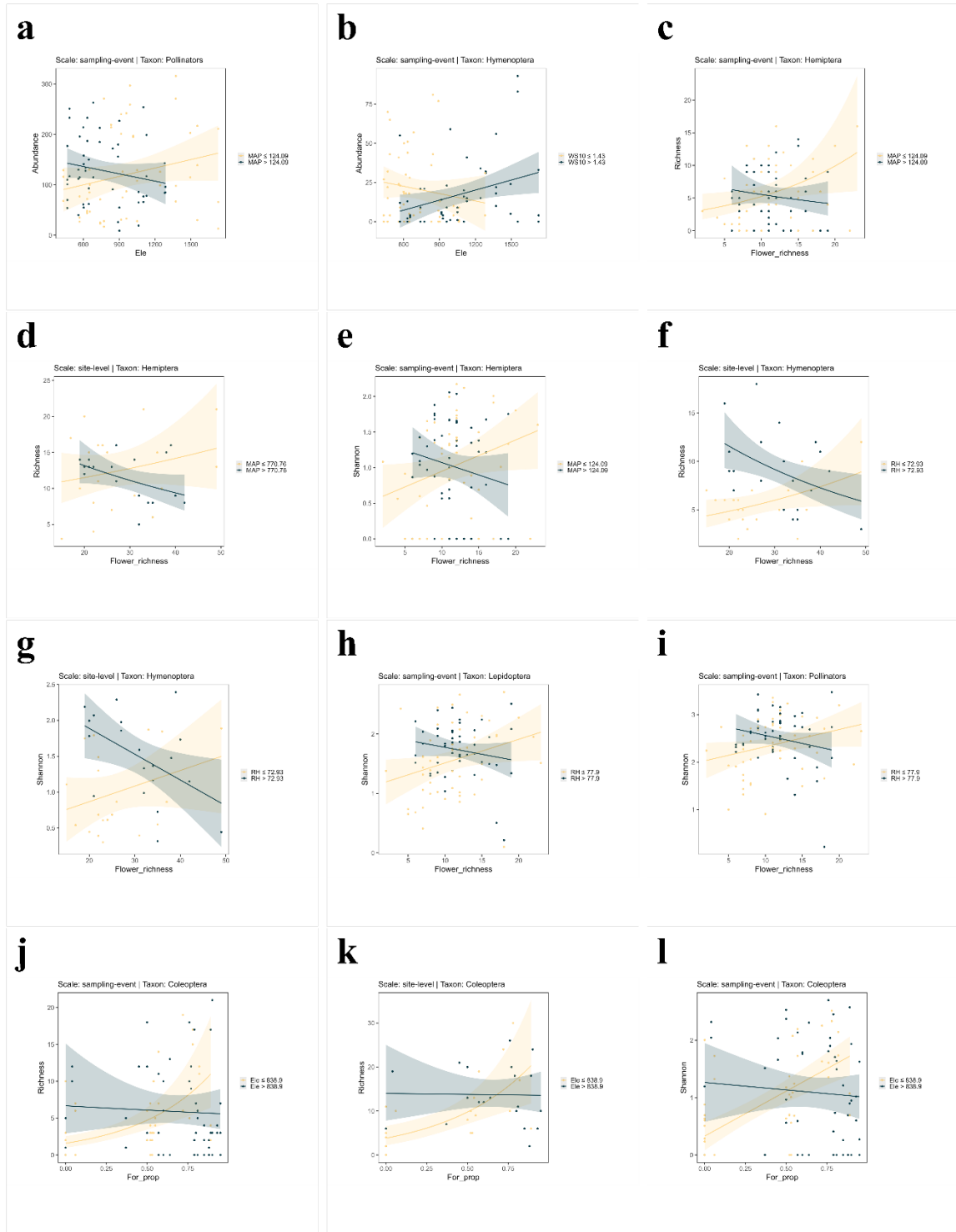


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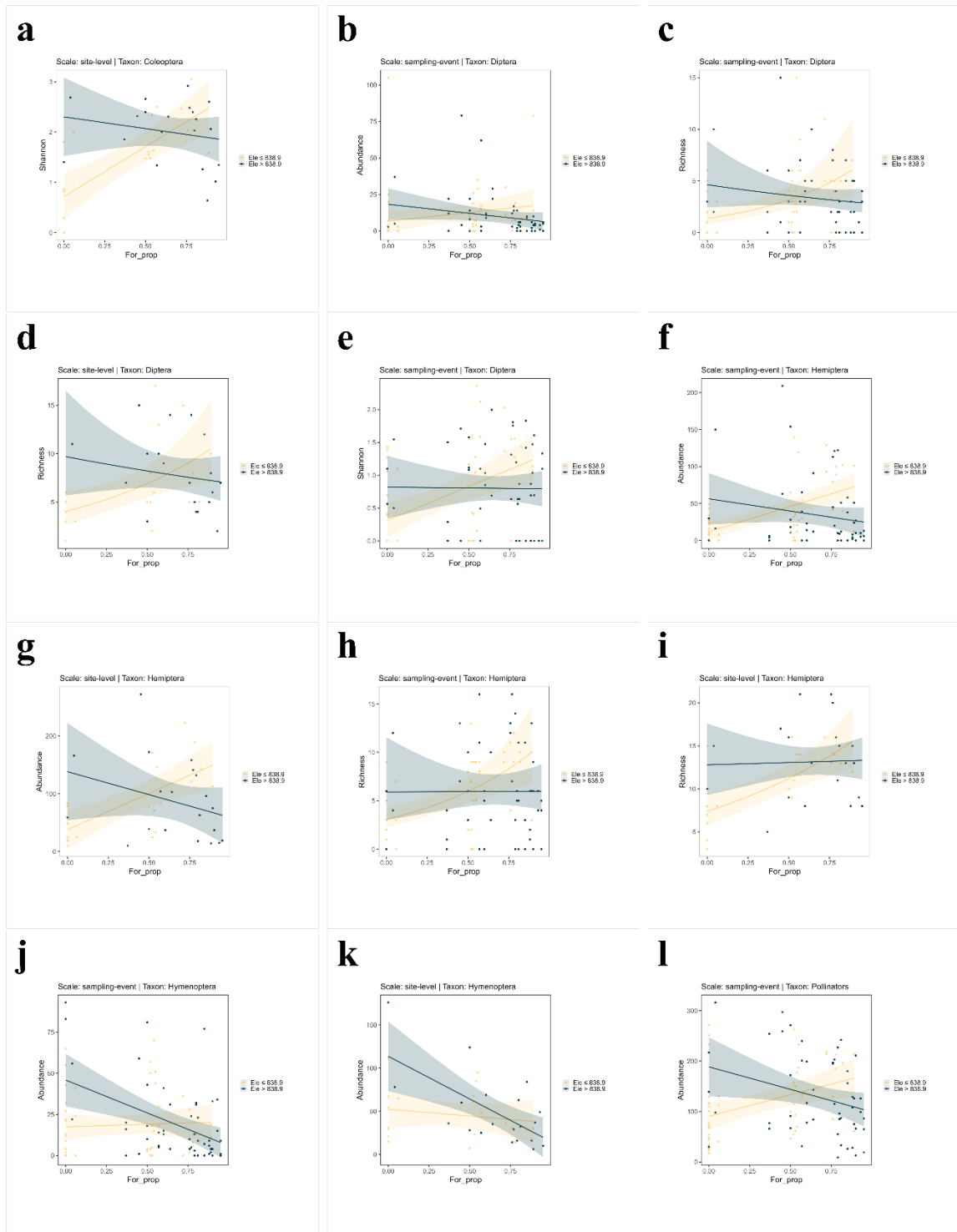


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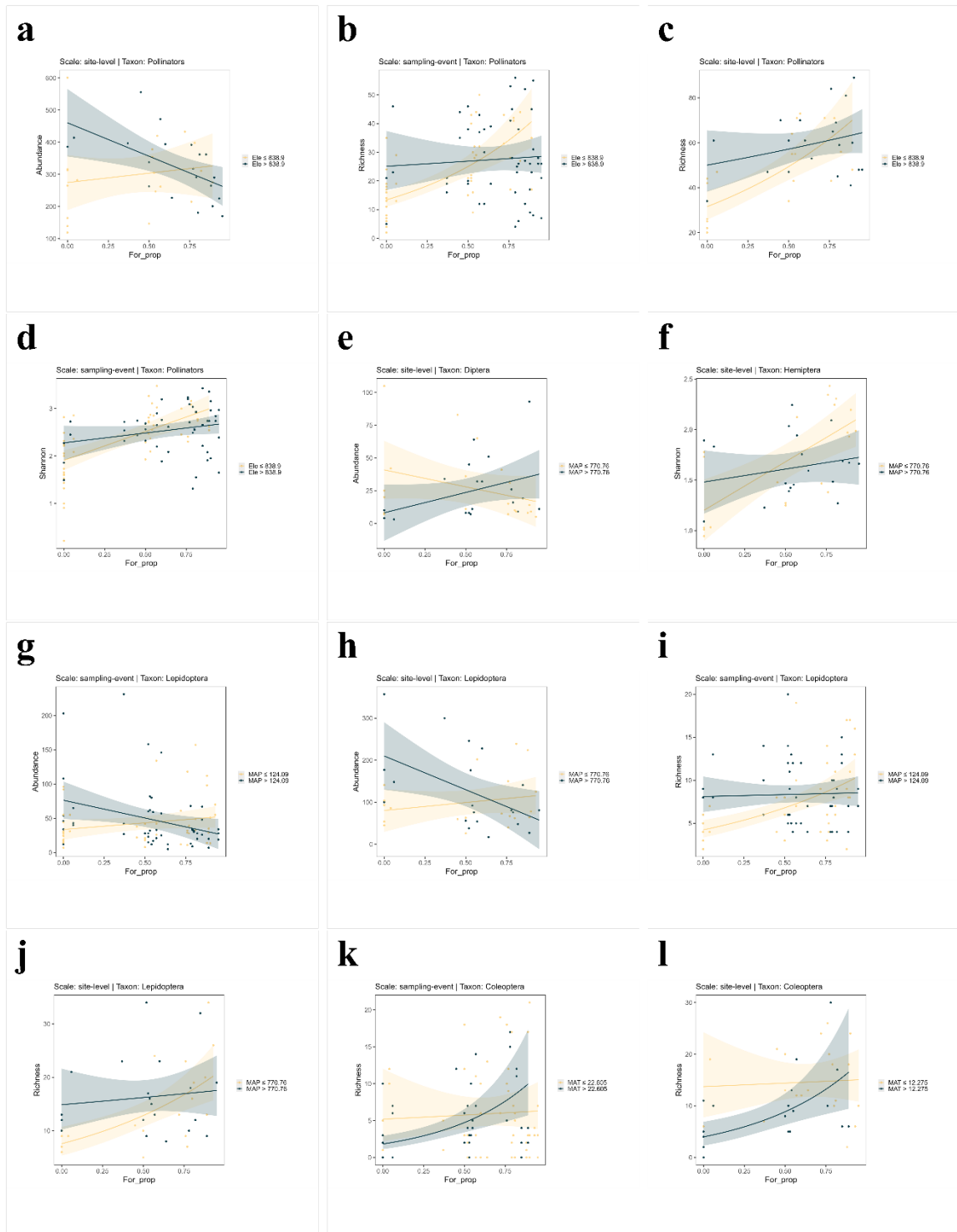


Figure S10i

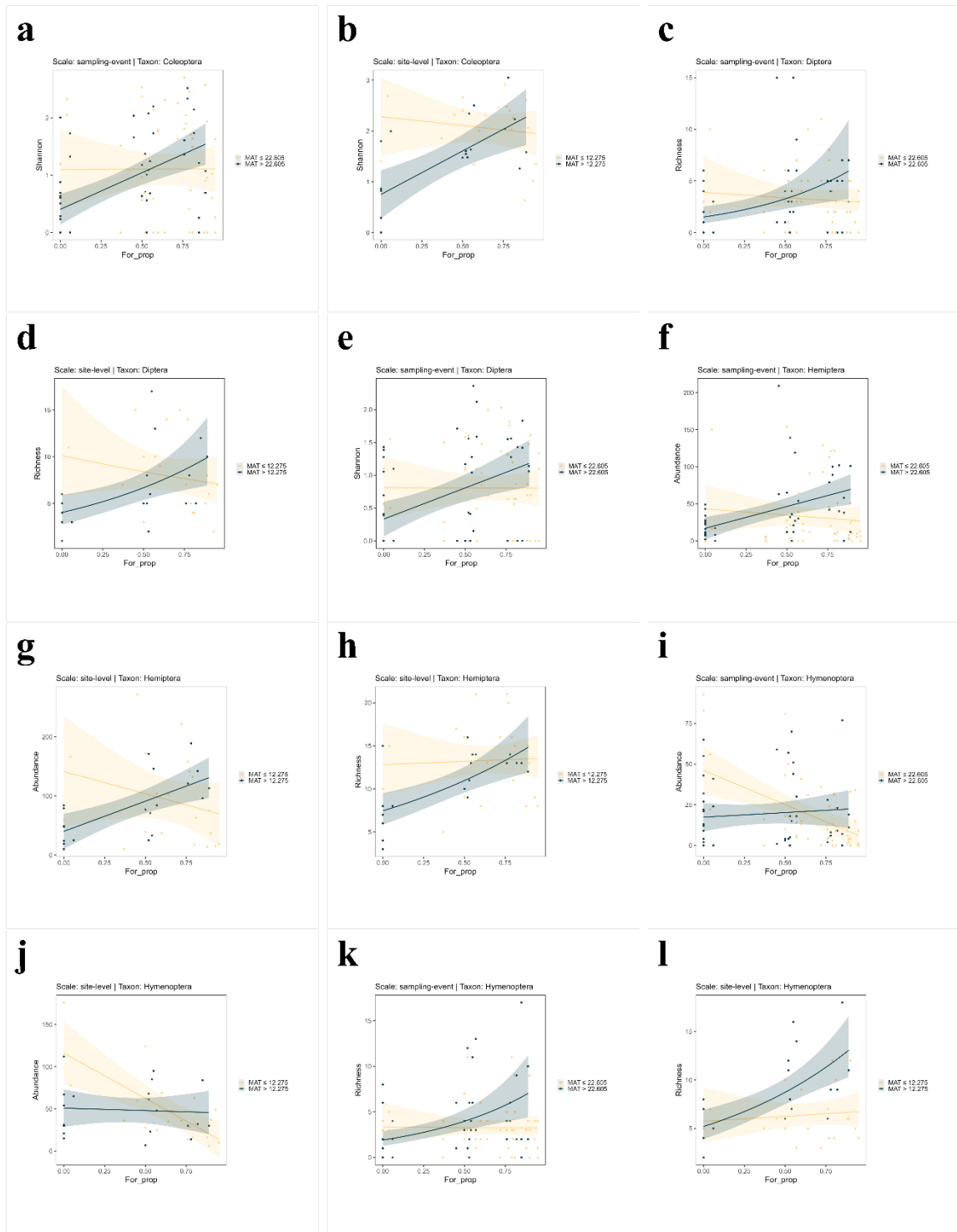


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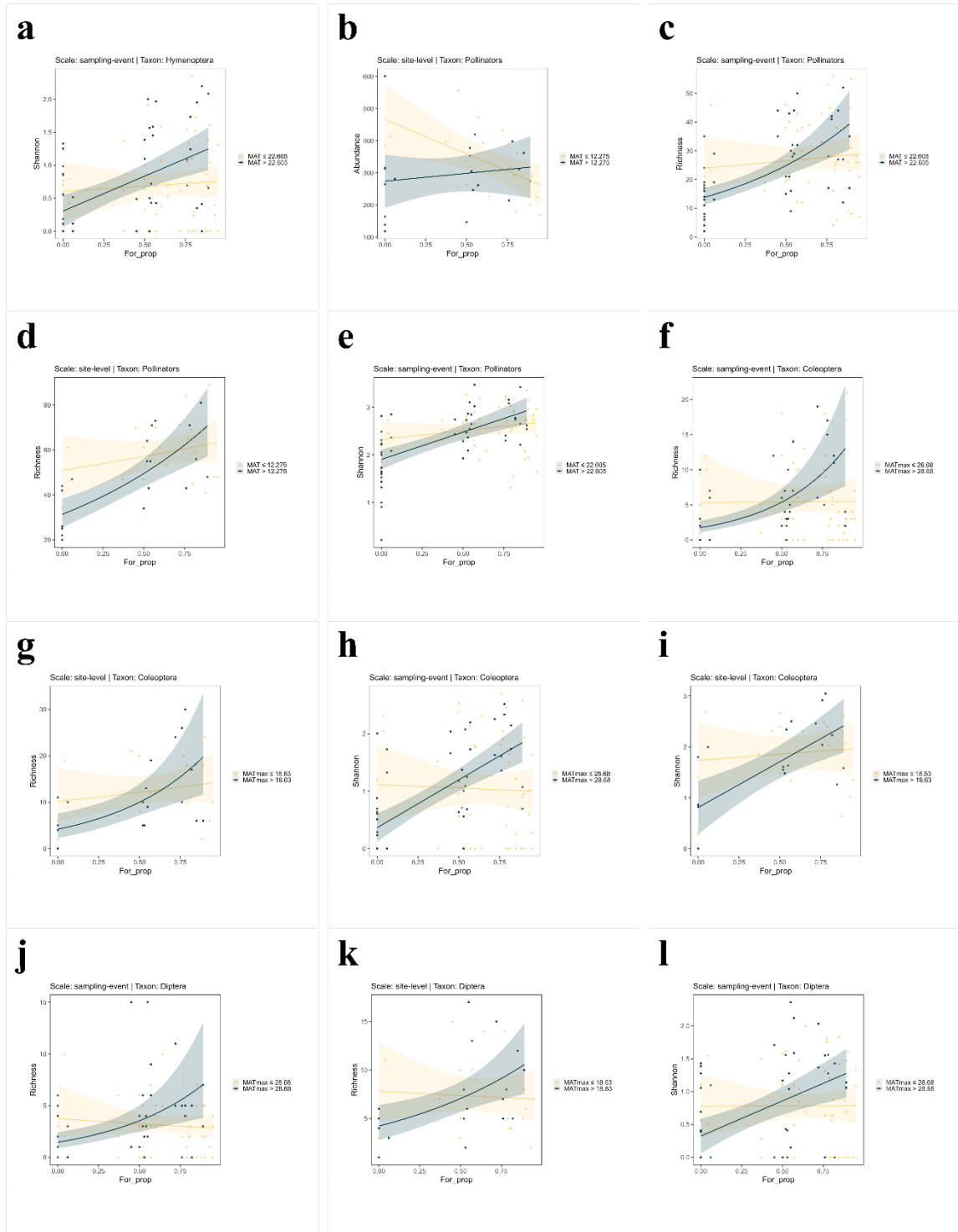


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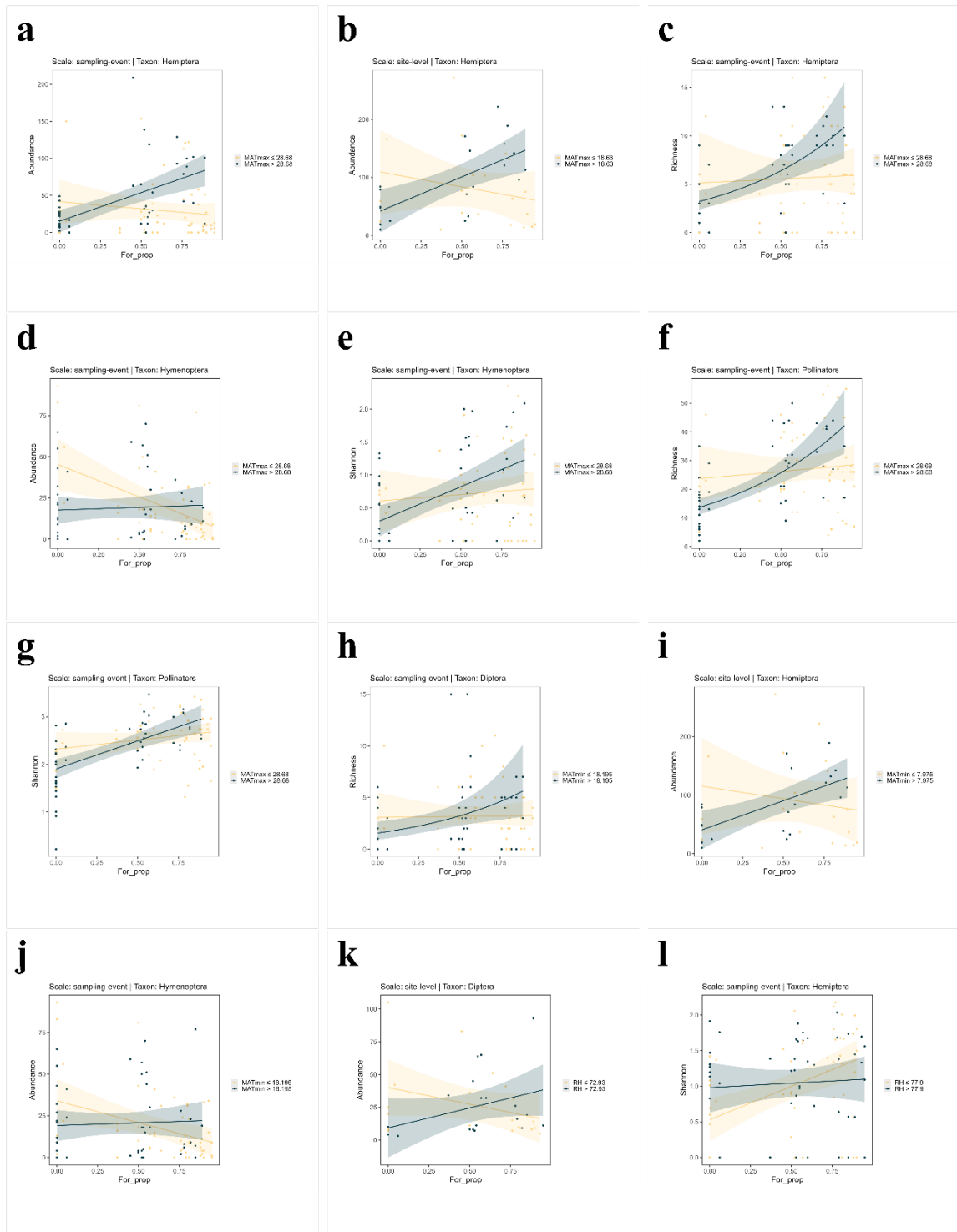


Figure S101

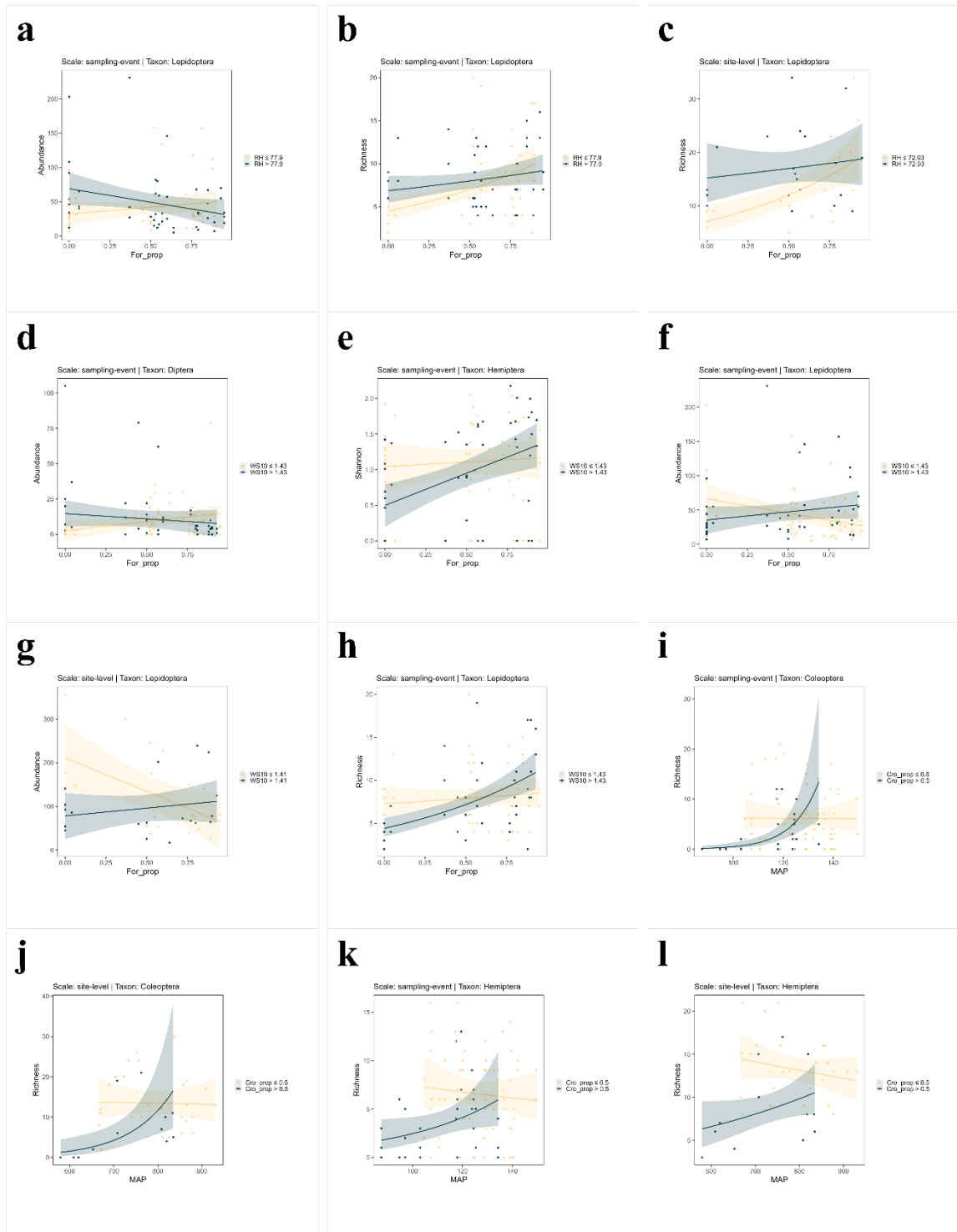


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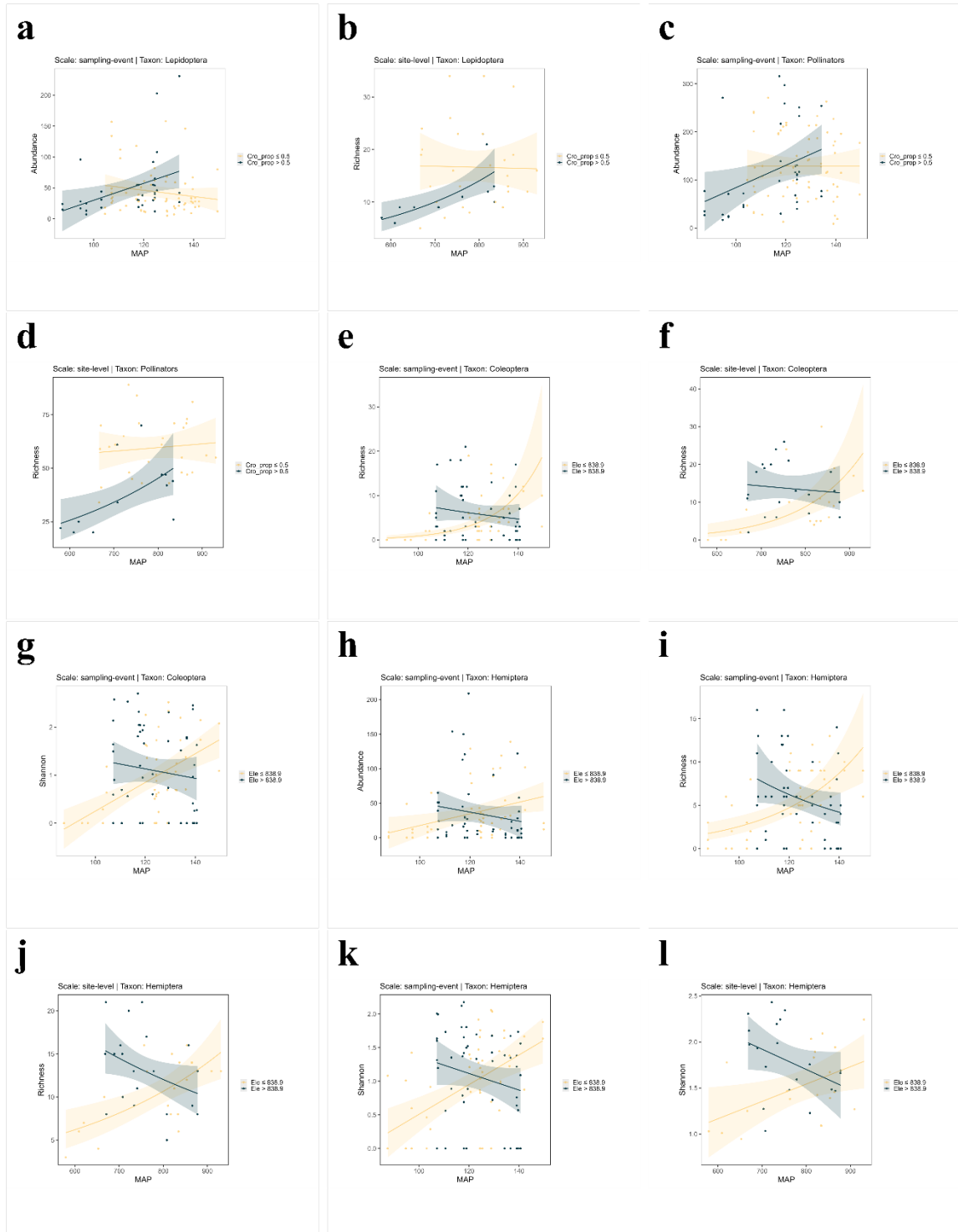


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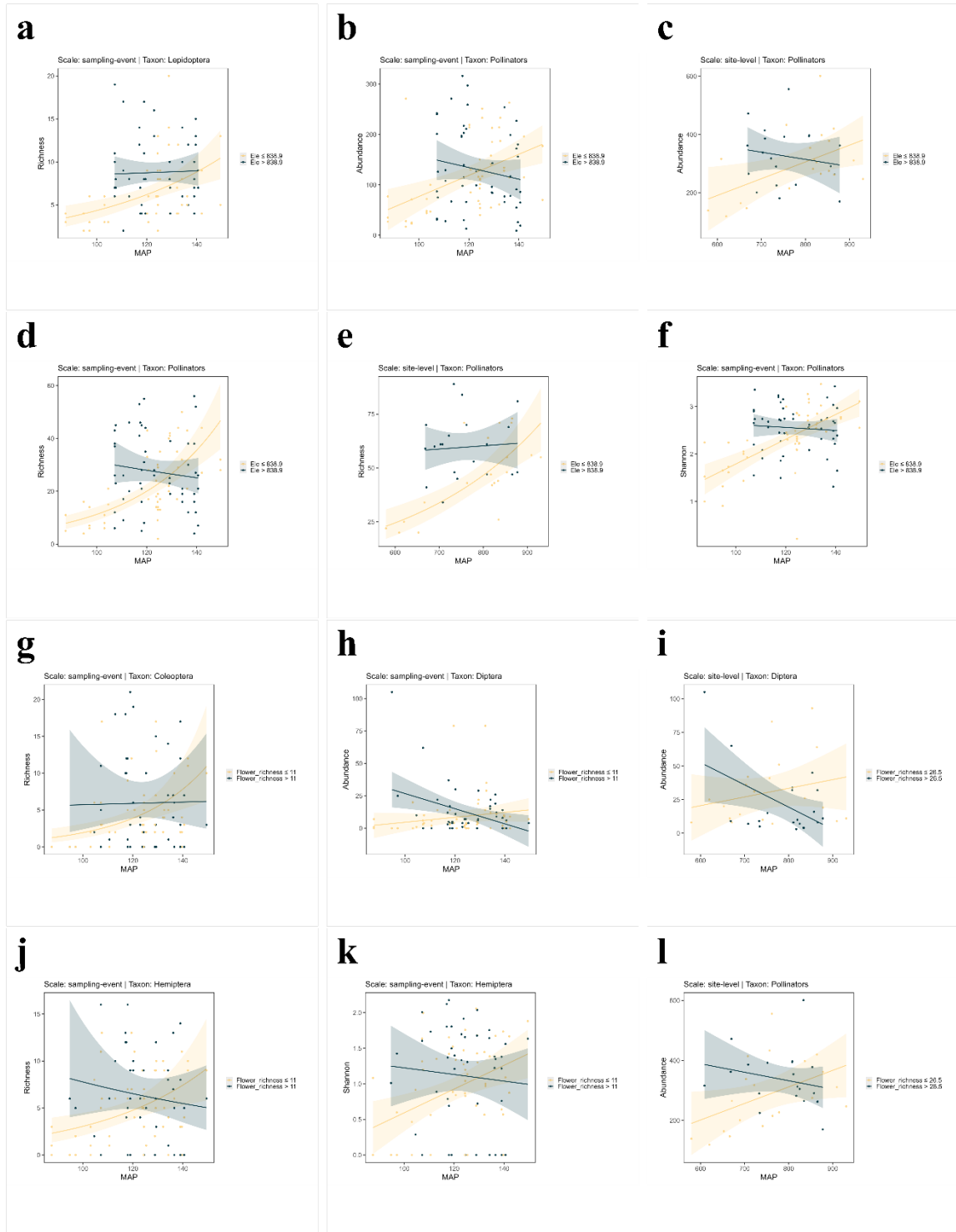


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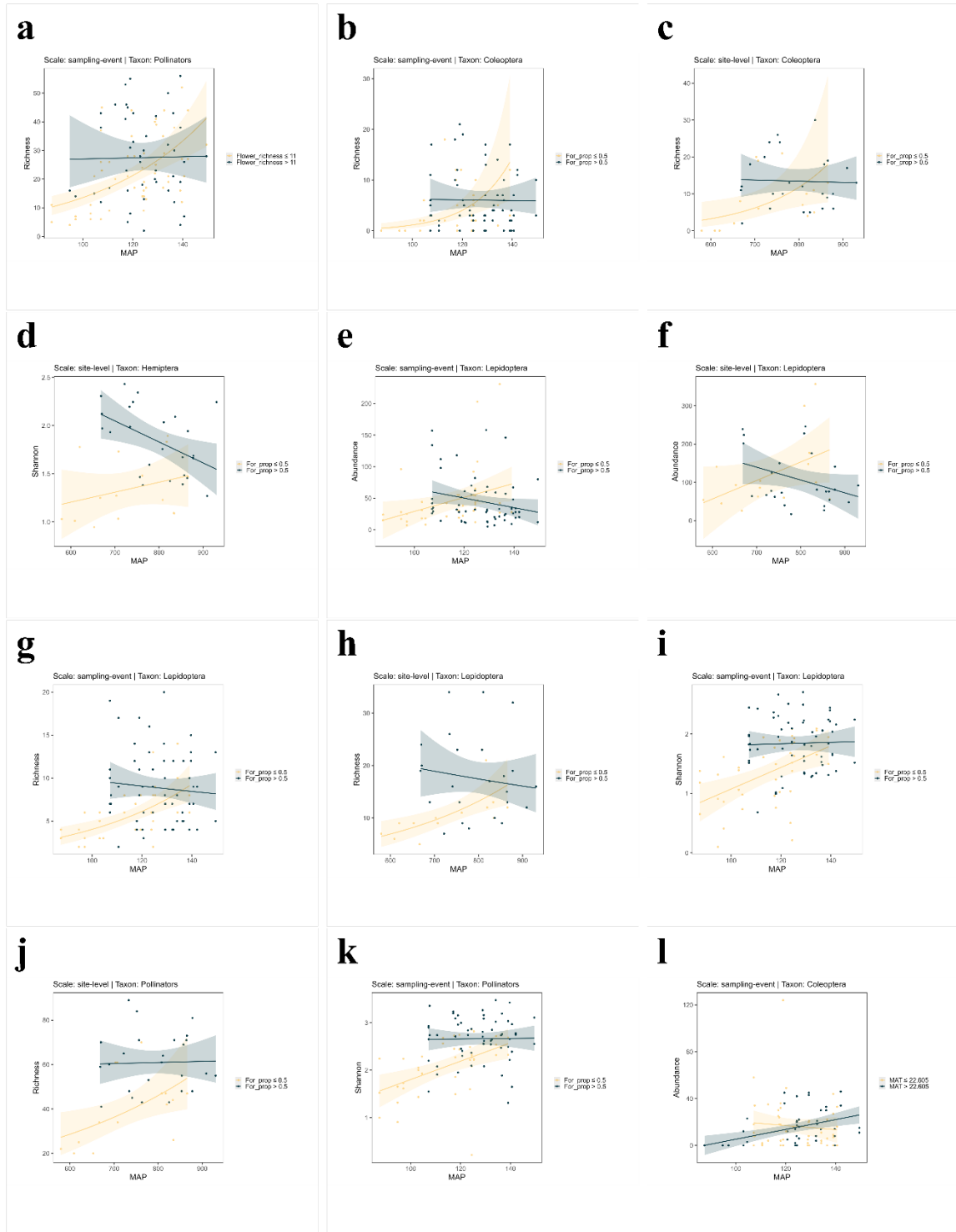


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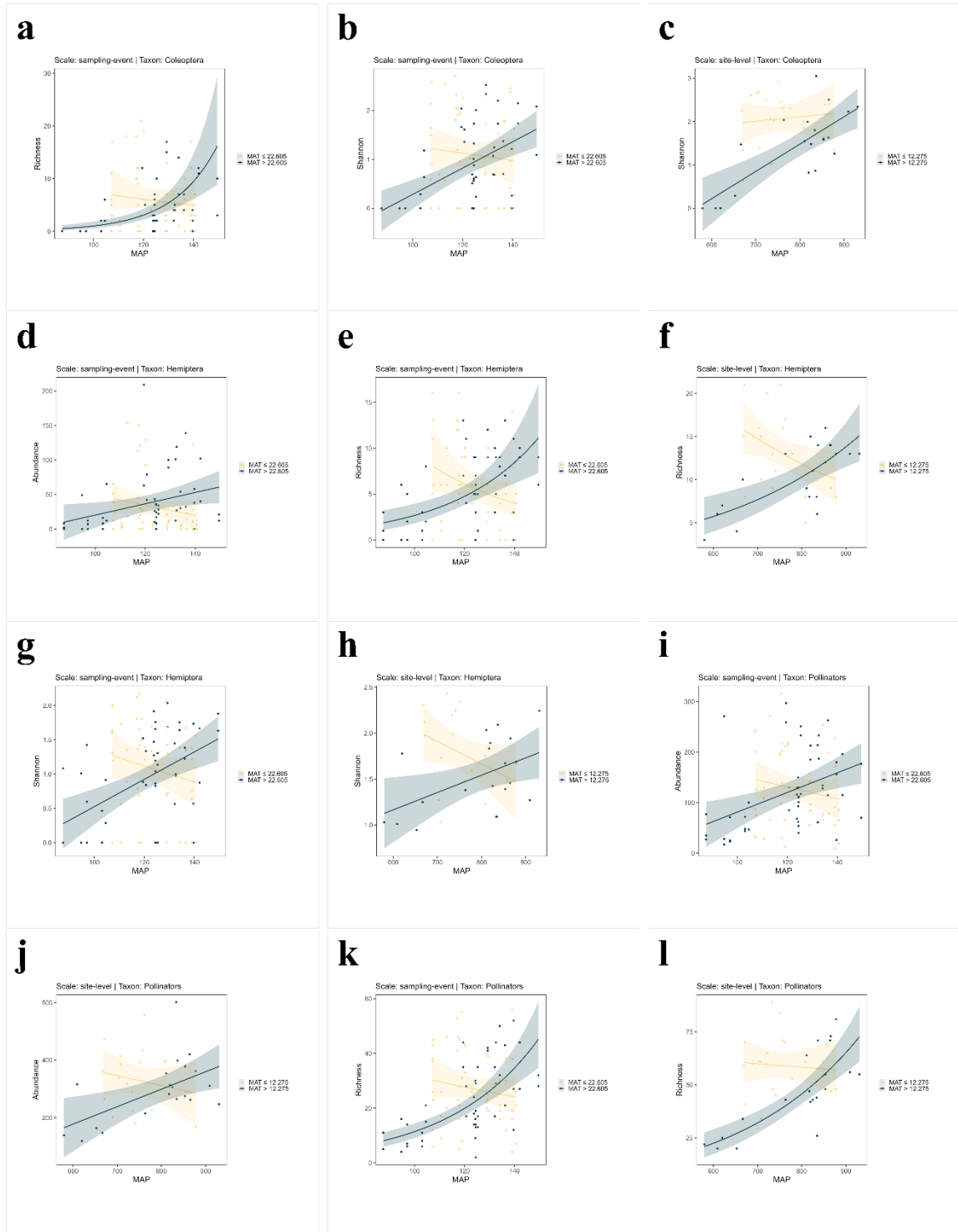


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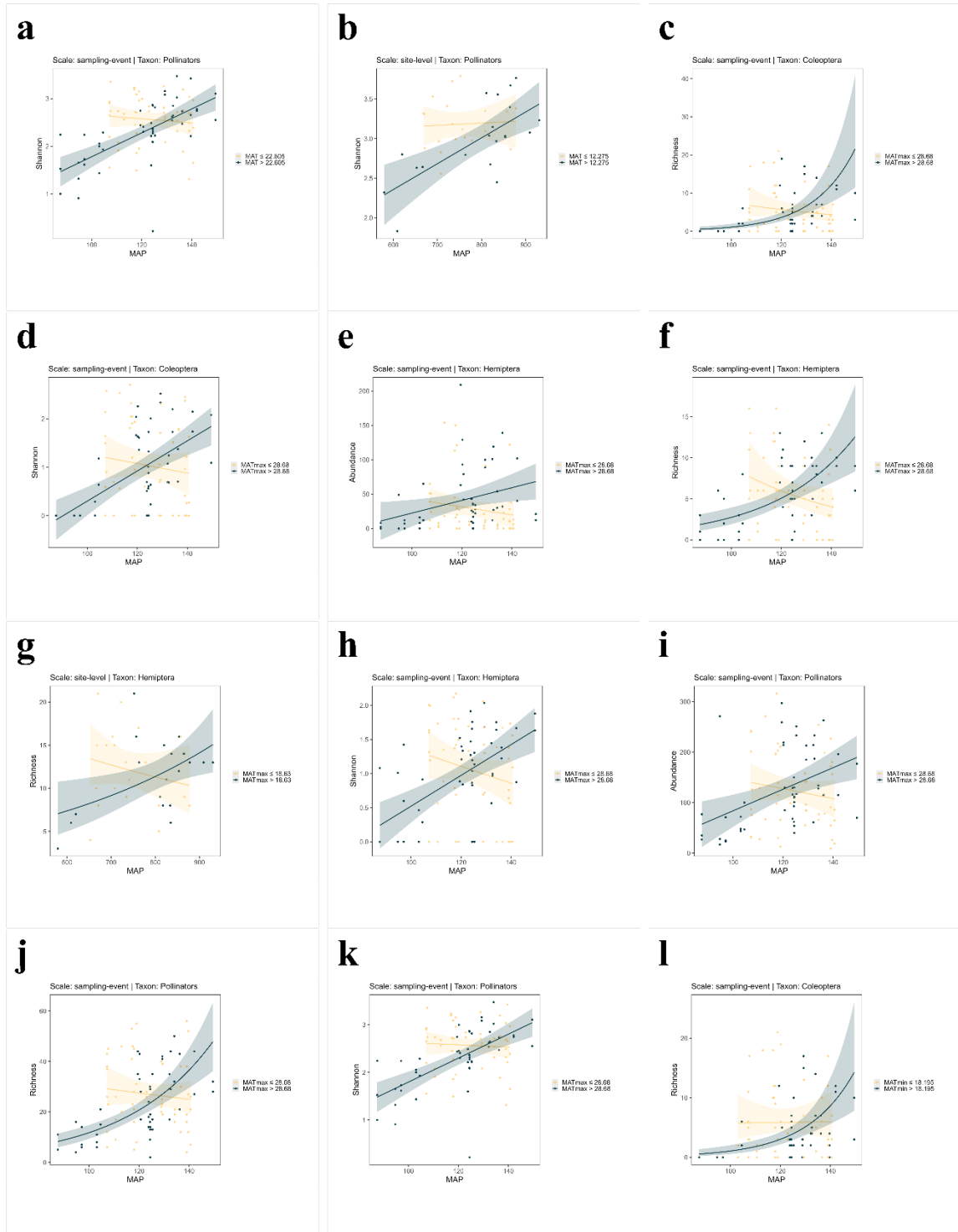


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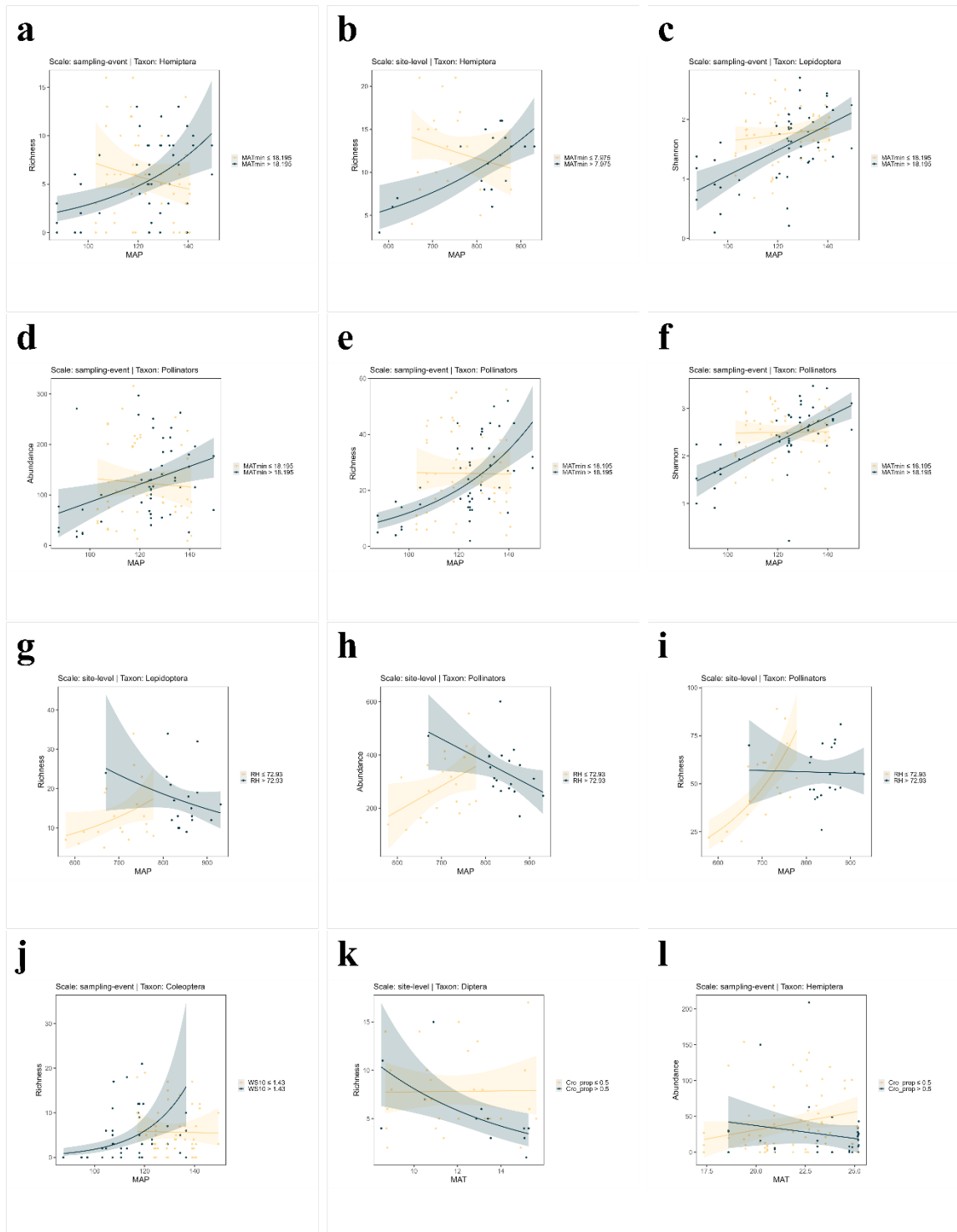


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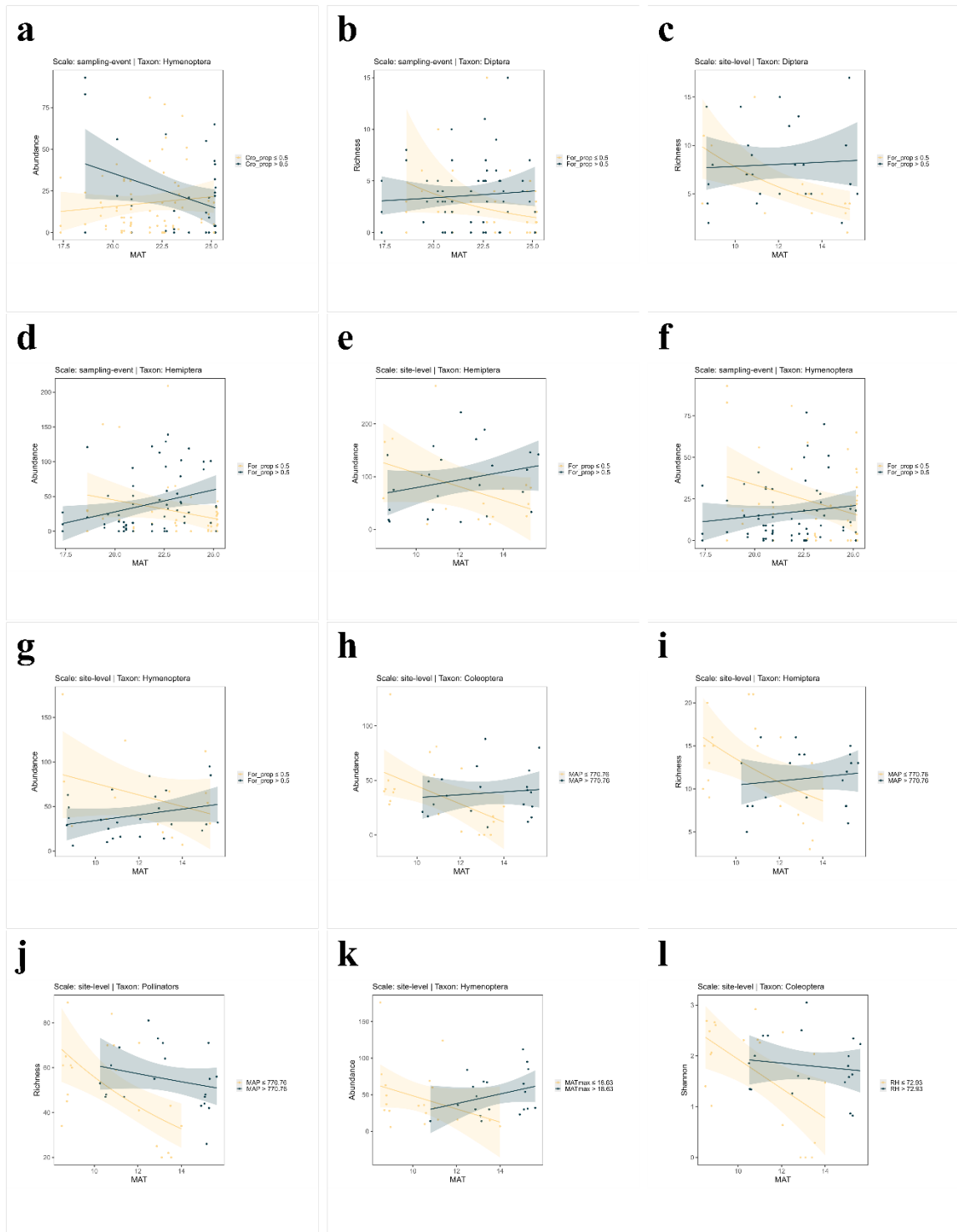


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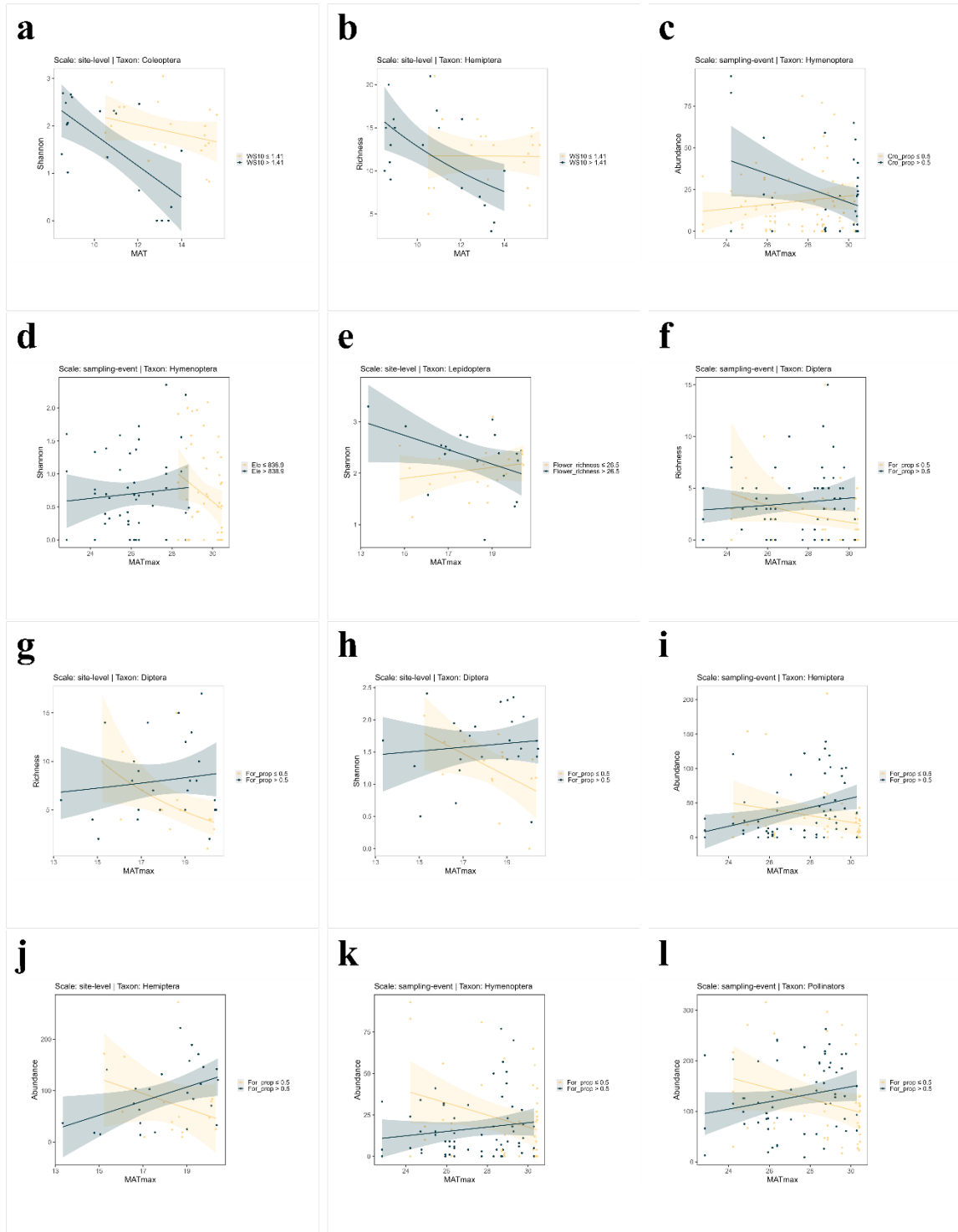


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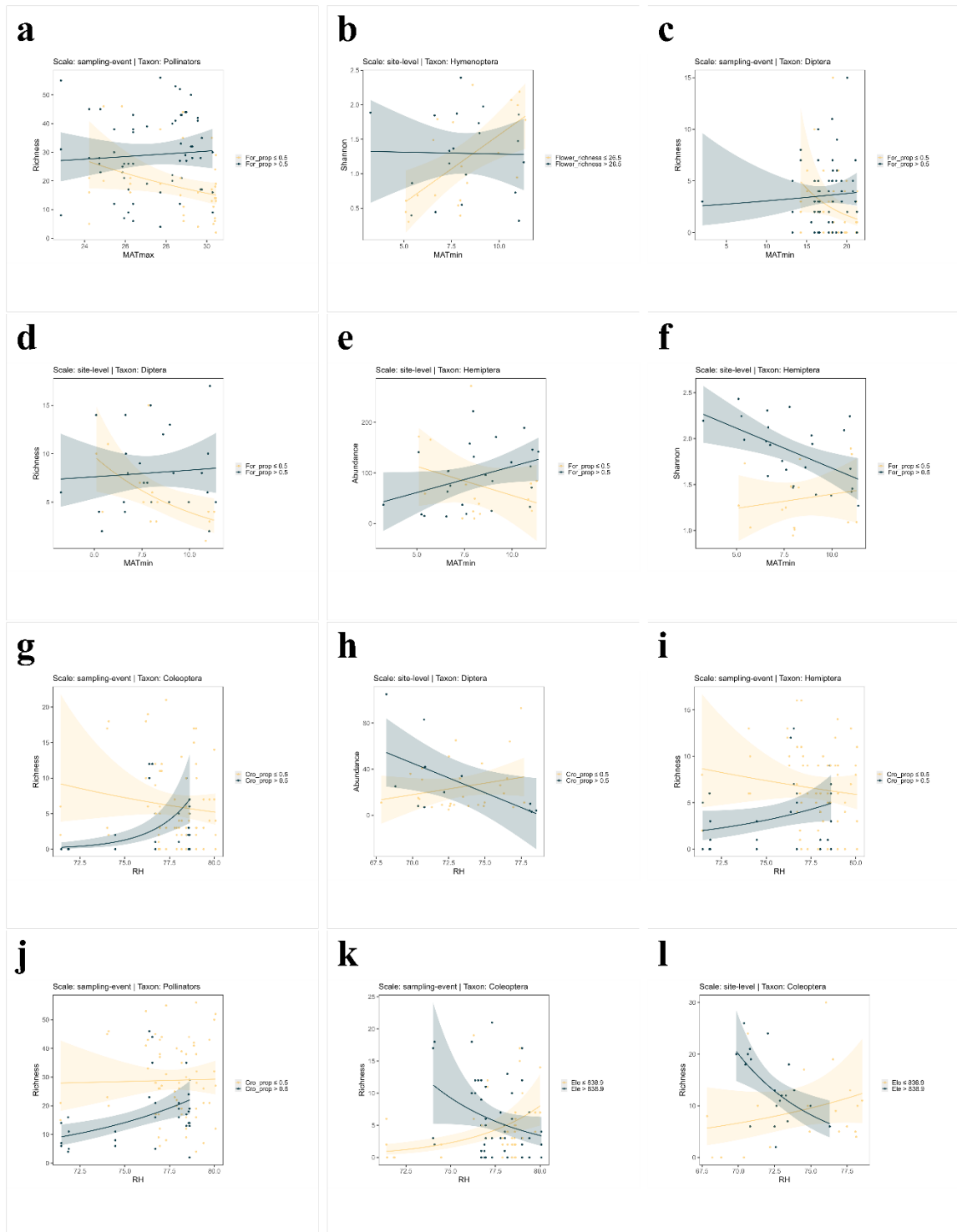


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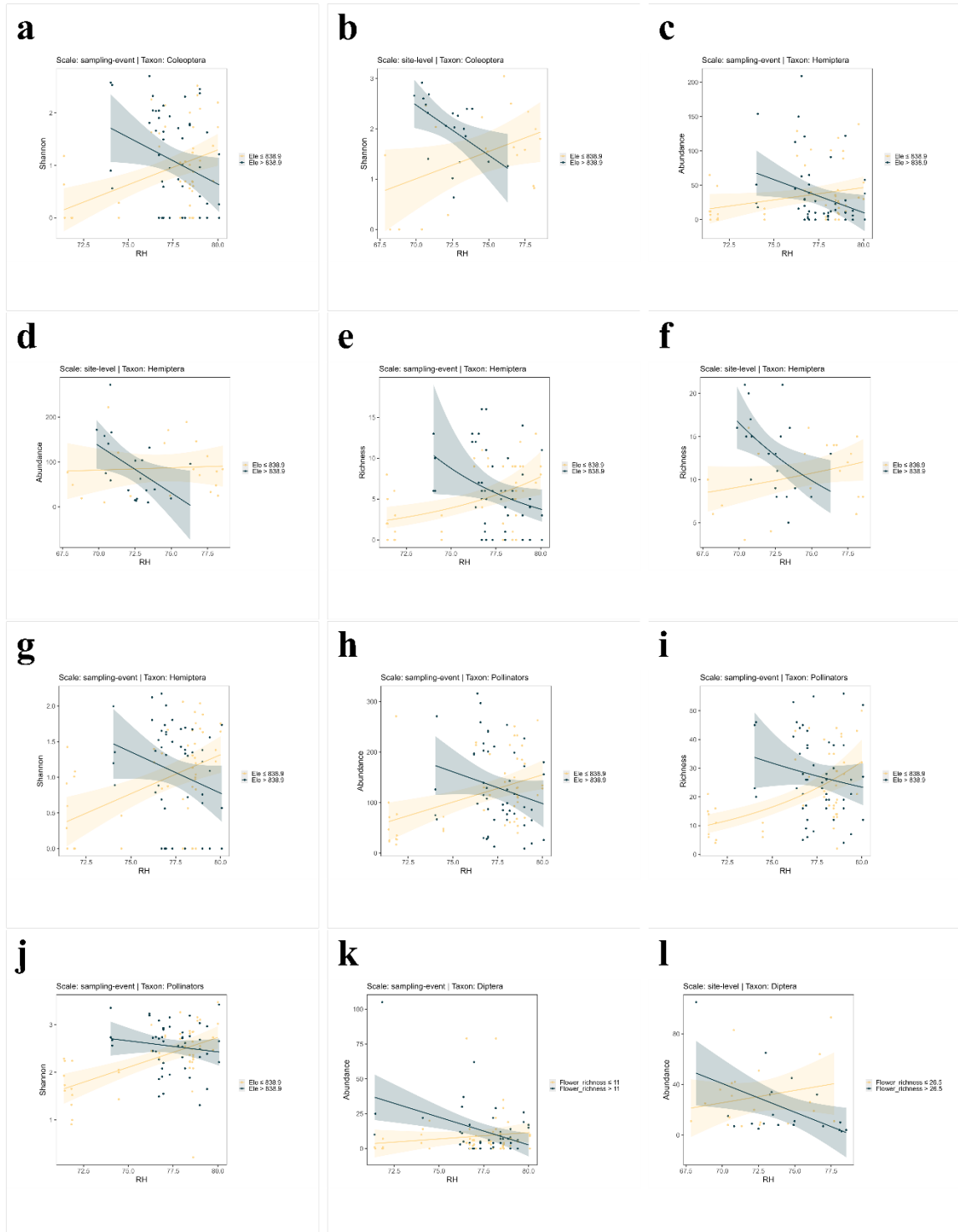


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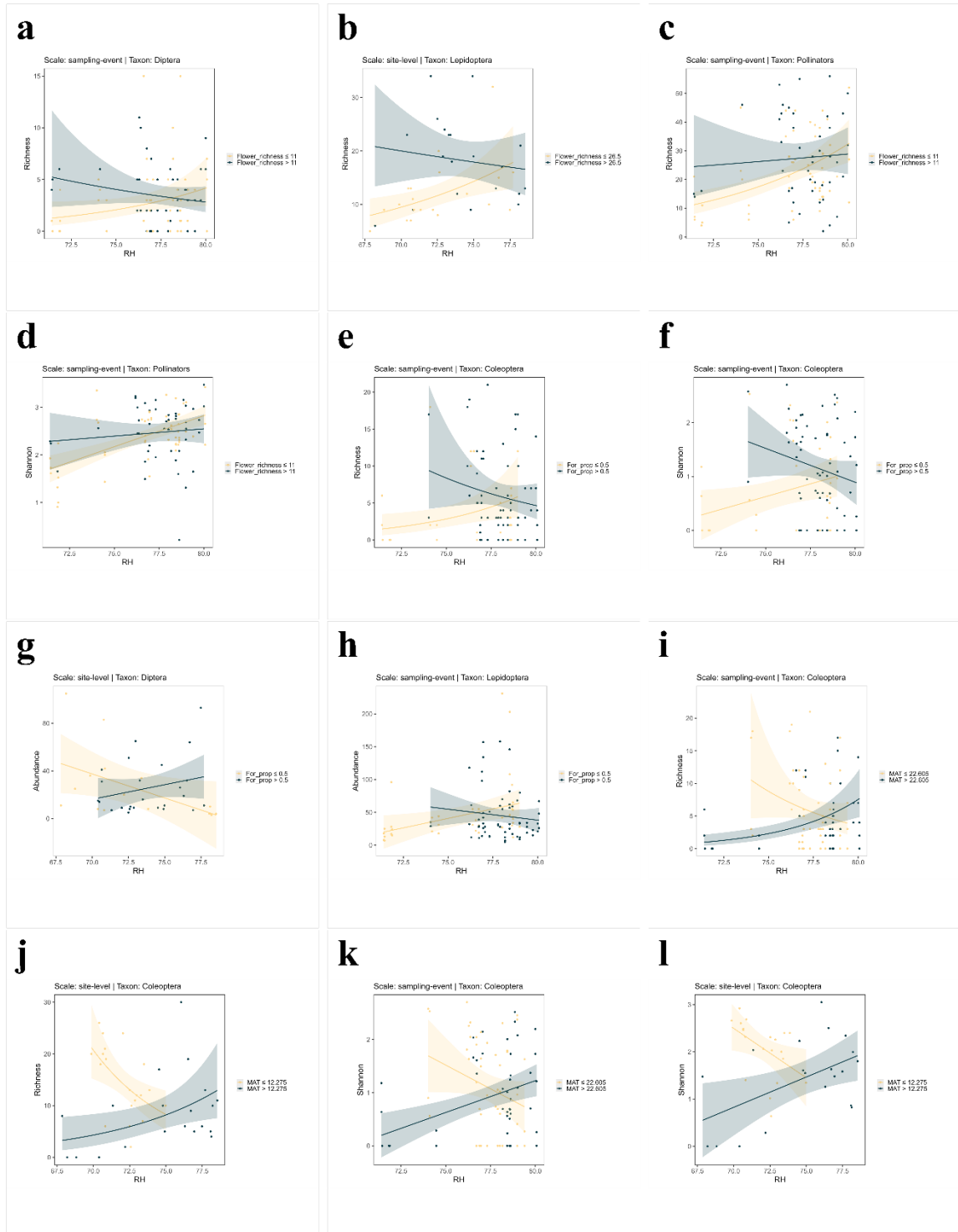


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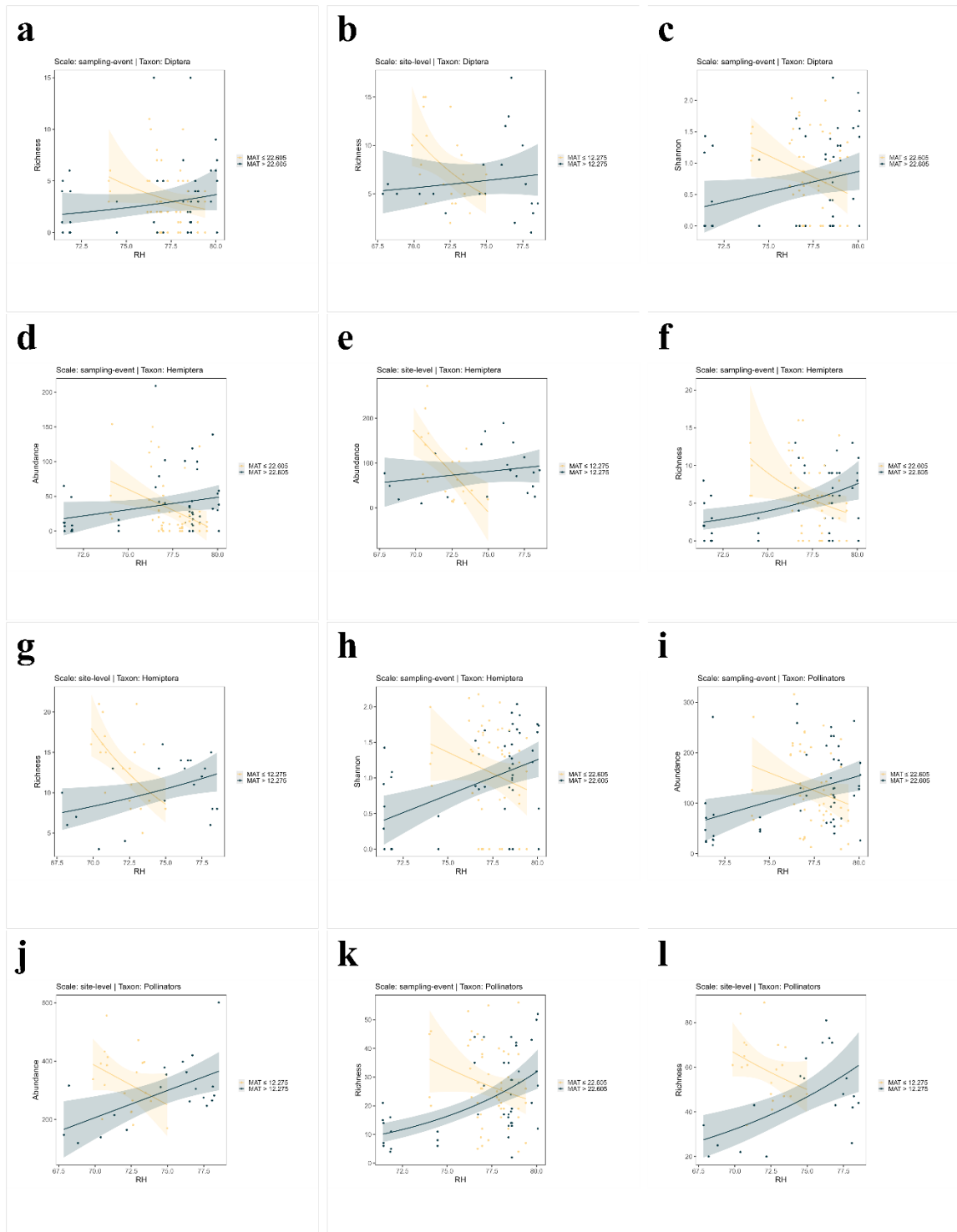


Figure S10y

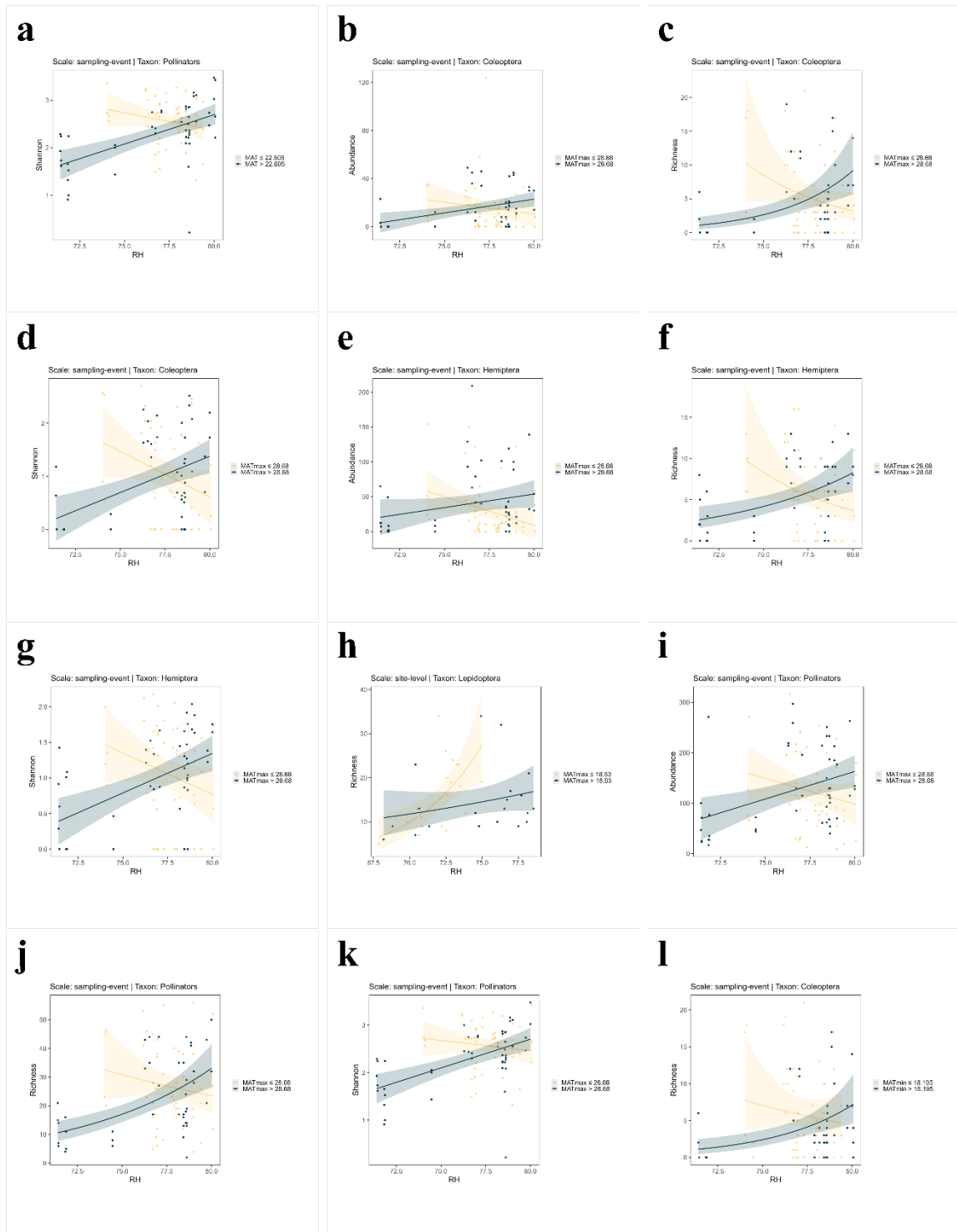


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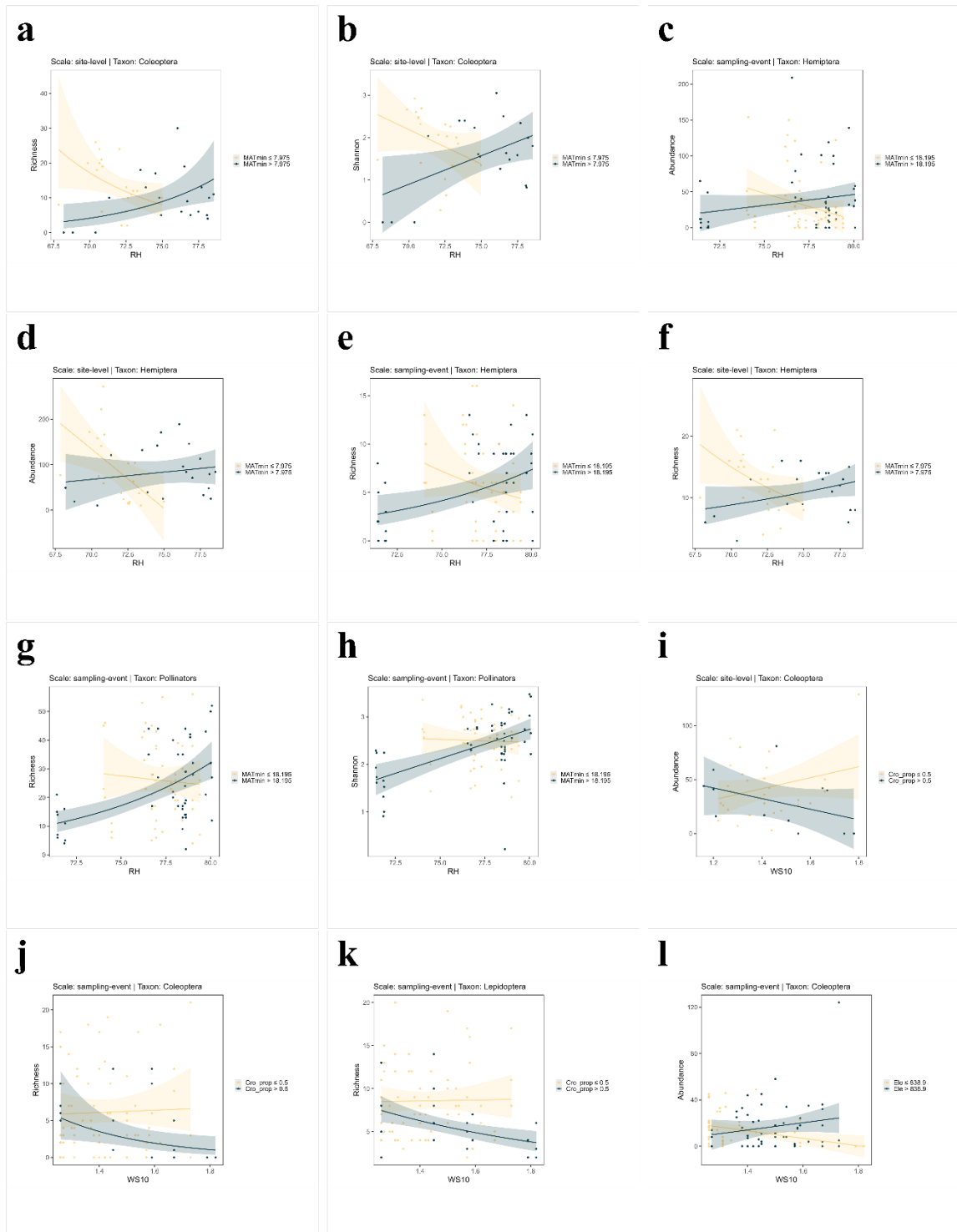


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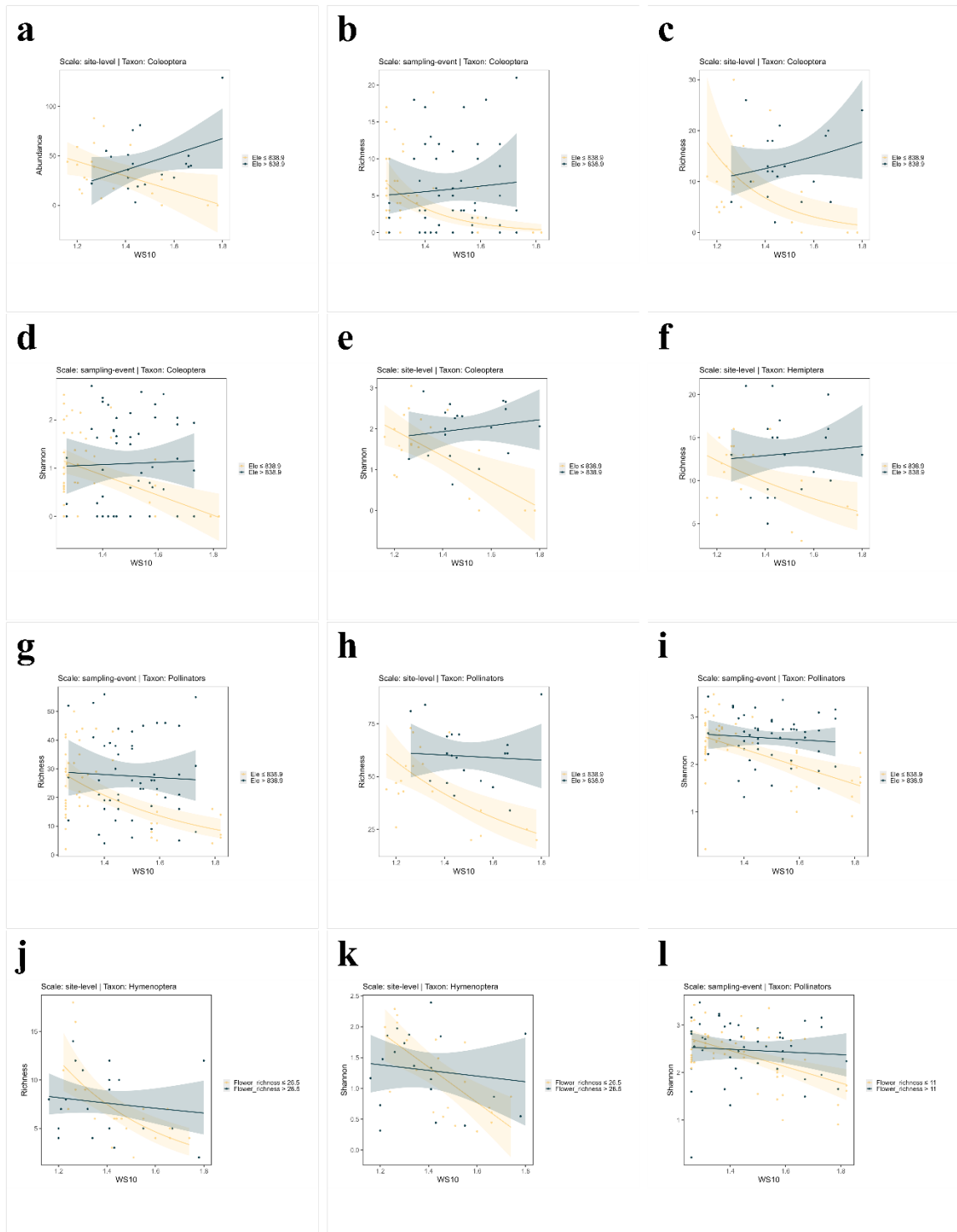


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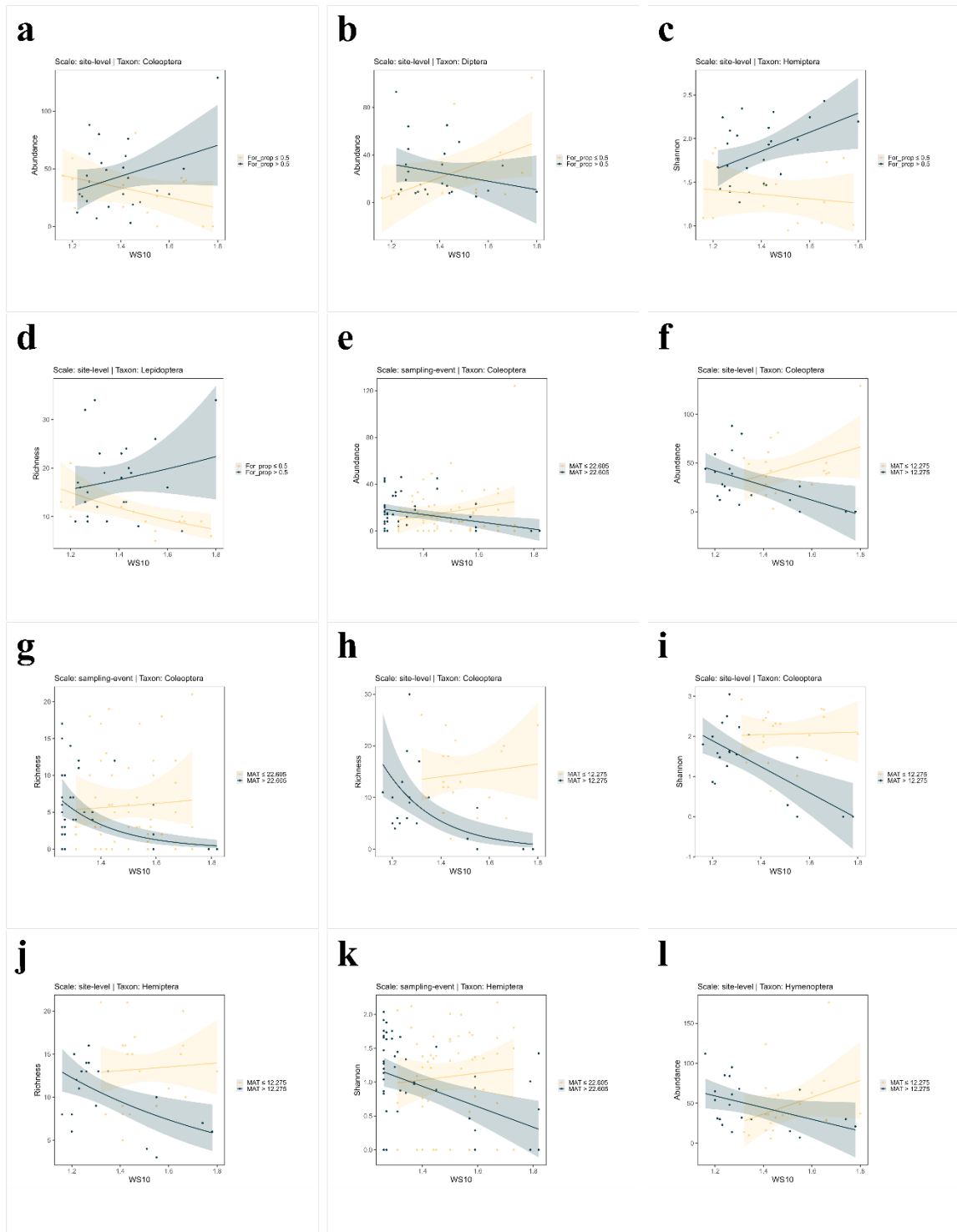


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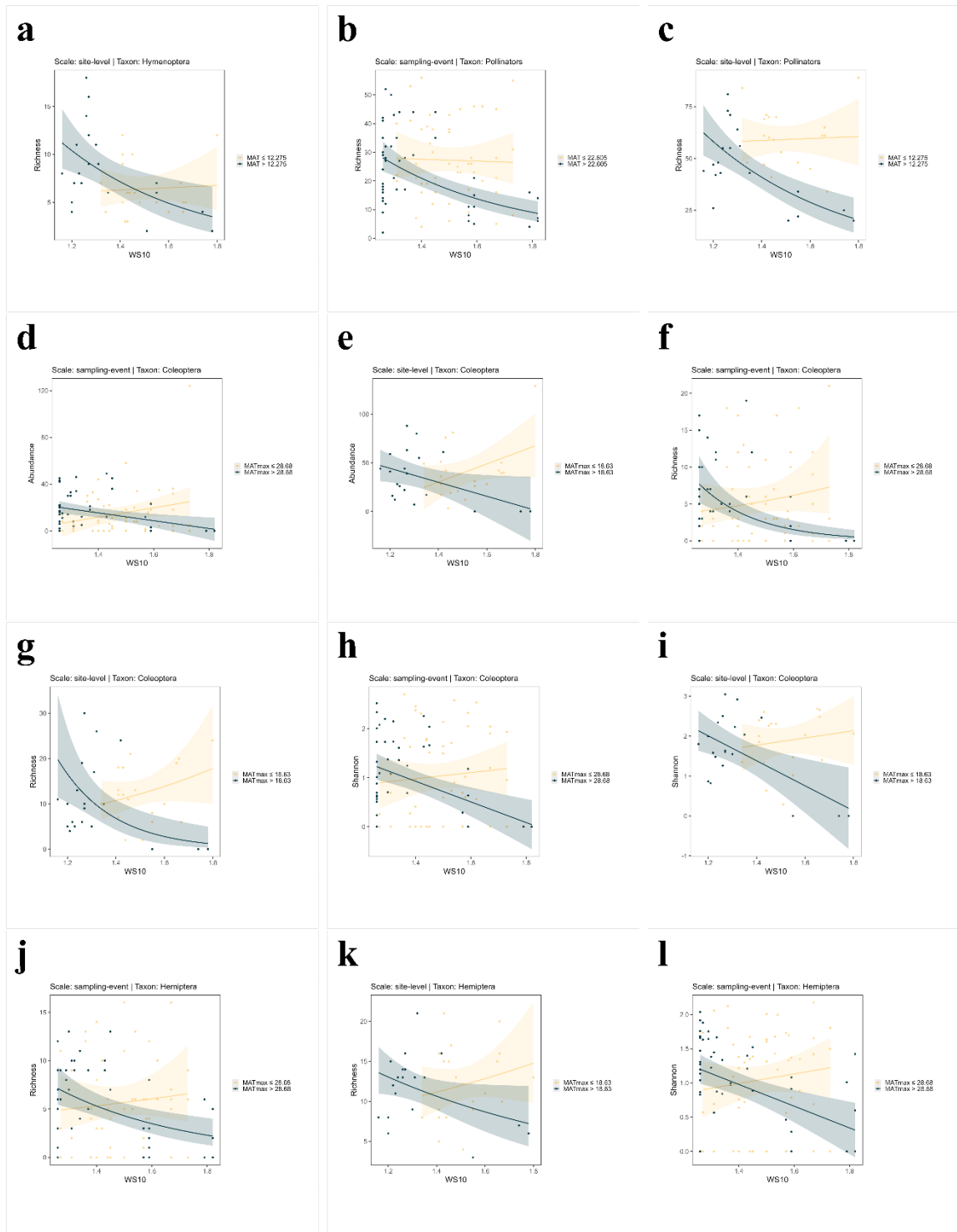


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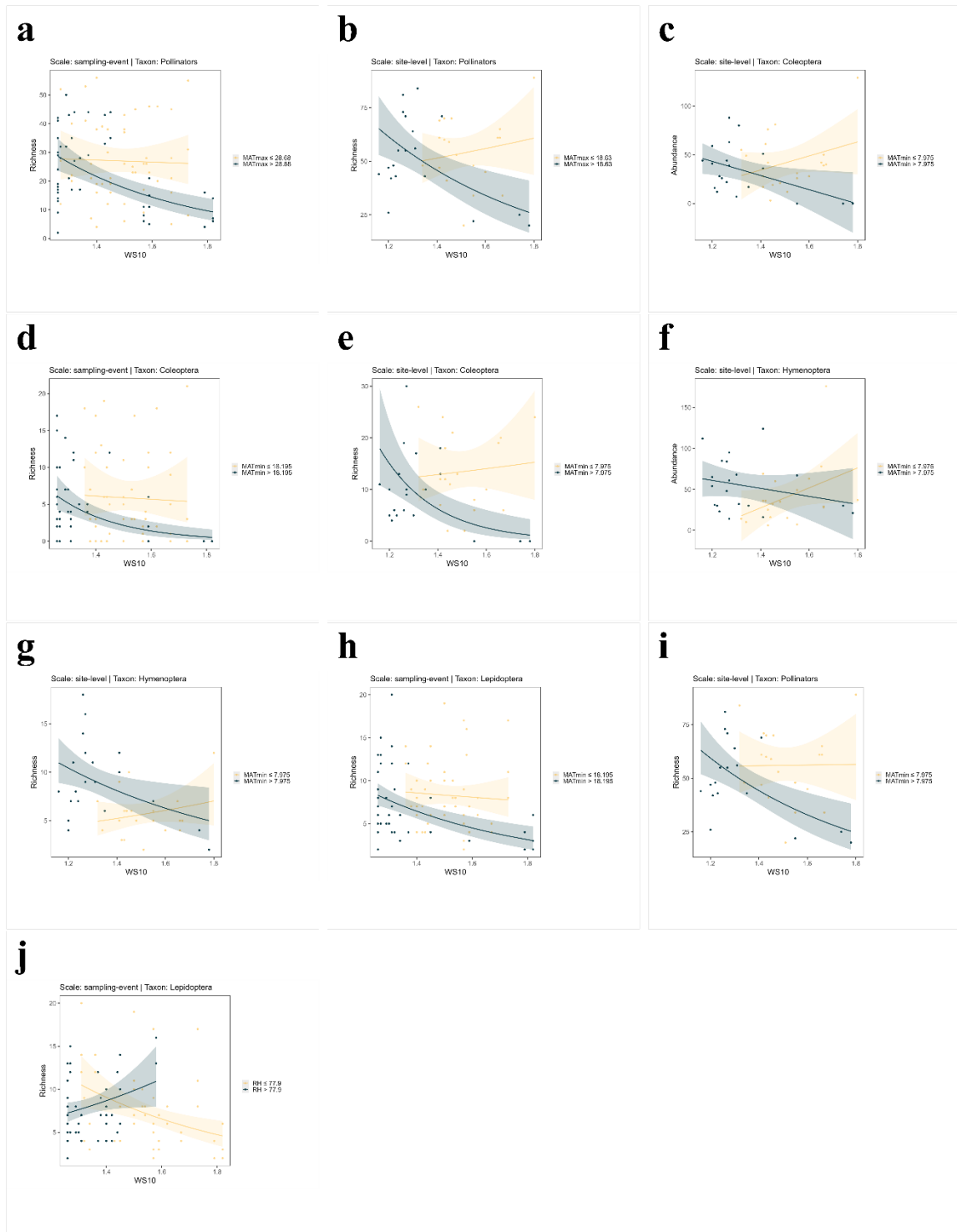


Figure S10ae