

Electronic Supplementary Information for
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**Metabolic theory of ecology successfully predicts distinct scaling of
ectoparasite load on hosts**

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This PDF file includes:

Figs. S1 to S2
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Captions for Datasets S1 to S2

Other supplementary materials for this manuscript include the following:

Datasets S1 to S2, which are deposited at Dryad (<https://doi.org/10.6075/J0P55KVH>)

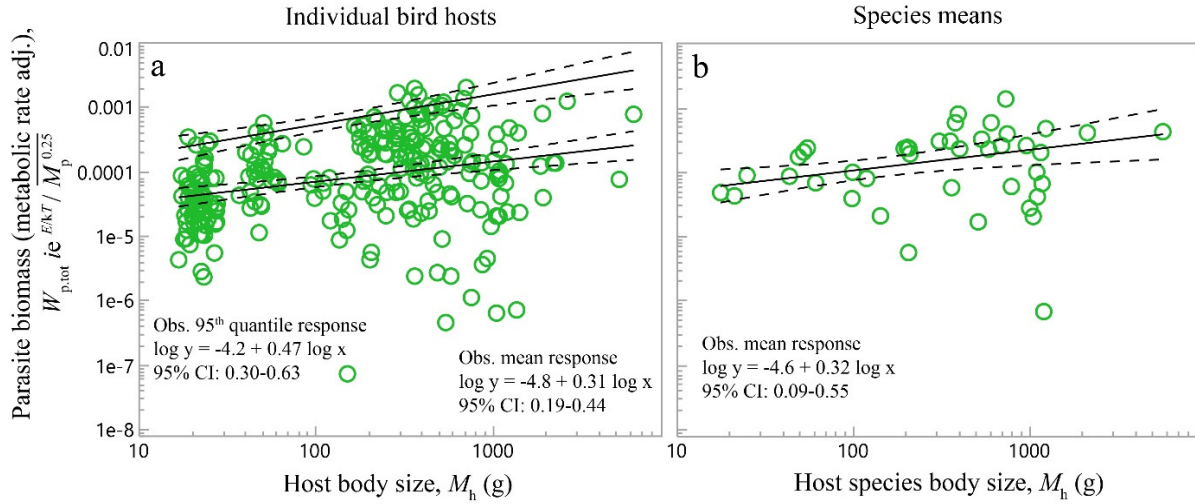


Fig. S1. The scaling with host size with metabolic-rate-adjusted parasite biomass. **(a)** uses individual host data and **(b)** uses host-species means as data. The top solid line in **a** is the 95th quantile regression, which reflects the scaling of maximum parasite load. The other solid lines are ordinary least squares regressions, which reflect the mean response. Dashed lines indicate 95% confidence curves. The 95% confidence intervals for the scaling slopes consistently include the theoretical expectation (0.42) for host-surface using parasites operating under energetic constraints, and exclude the prediction (0.75) for host-volume using parasites.

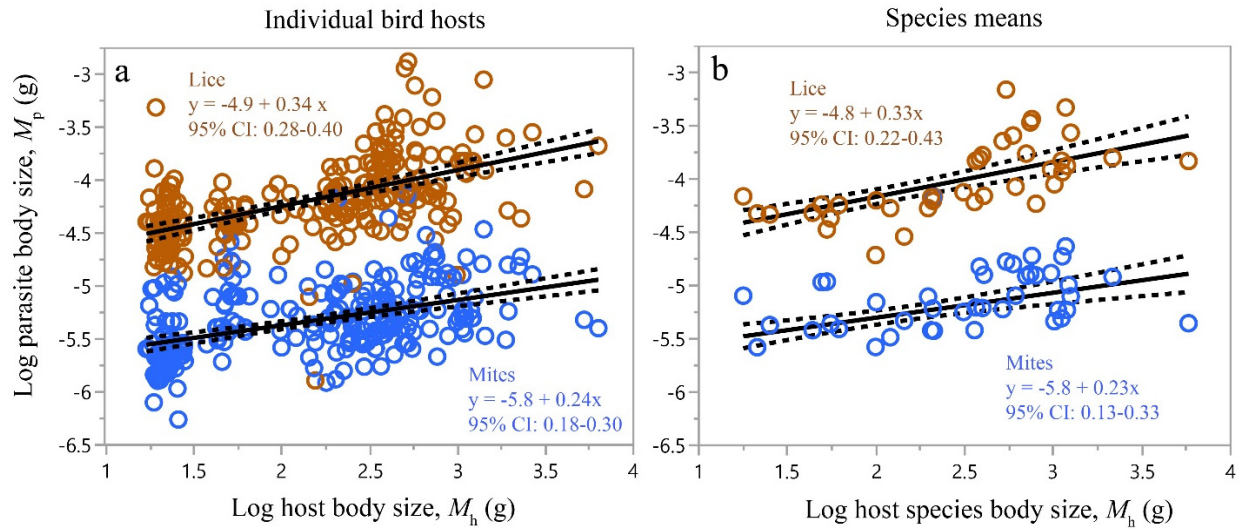


Fig. S2. Larger-bodied hosts have larger-bodied ectoparasitic mites and lice. The relationship occurs within both major taxonomic groups of bird ectoparasites mites (Arachnida / Acari) and lice (Insecta / Phthiraptera) using either **(a)** individual ectoparasite morphospecies on individual hosts or **(b)** averages for host species.

Table S1 | Summary table of sampled host bird species.

Order	Family	Species	Common Name	N
Anseriformes	Anatidae	<i>Anas clypeata</i>	Northern Shoveler	1
Anseriformes	Anatidae	<i>Aythya affinis</i>	Lesser Scaup	2
Anseriformes	Anatidae	<i>Aythya americana</i>	Redhead	1
Anseriformes	Anatidae	<i>Aythya marila</i>	Greater Scaup	9
Anseriformes	Anatidae	<i>Aythya valisineria</i>	Canvasback	1
Anseriformes	Anatidae	<i>Branta bernicla</i>	Brant	1
Anseriformes	Anatidae	<i>Branta canadensis</i>	Canada Goose	2
Anseriformes	Anatidae	<i>Bucephala albeola</i>	Bufflehead	12
Anseriformes	Anatidae	<i>Melanitta perspicillata</i>	Surf Scoter	1
Anseriformes	Anatidae	<i>Mergus serrator</i>	Red-breasted Merganser	1
Anseriformes	Anatidae	<i>Oxyura jamaicensis</i>	Ruddy Duck	6
Charadriiformes	Charadriidae	<i>Charadrius semipalmatus</i>	Semipalmated Plover	11
Charadriiformes	Charadriidae	<i>Pluvialis squatarola</i>	Black-bellied Plover	4
Charadriiformes	Laridae	<i>Larus californicus</i>	California Gull	5
Charadriiformes	Laridae	<i>Larus occidentalis</i>	Western Gull	2
Charadriiformes	Laridae	<i>Larus philadelphia</i>	Bonapart's Gull	7
Charadriiformes	Laridae	<i>Sterna forsteri</i>	Forster's Tern	7
Charadriiformes	Recurvirostridae	<i>Himantopus mexicanus</i>	Black-necked Stilt	10
Charadriiformes	Recurvirostridae	<i>Recurvirostra americana</i>	American Avocet	5
Charadriiformes	Scolopacidae	<i>Actitis macularius</i>	Spotted Sandpiper	3
Charadriiformes	Scolopacidae	<i>Calidris alba</i>	Sanderling	1
Charadriiformes	Scolopacidae	<i>Calidris alpina</i>	Dunlin	13
Charadriiformes	Scolopacidae	<i>Calidris mauri</i>	Western Sandpiper	17
Charadriiformes	Scolopacidae	<i>Calidris minutilla</i>	Least Sandpiper	53
Charadriiformes	Scolopacidae	<i>Catoptrophorus semipalmatus</i>	Willet	12
Charadriiformes	Scolopacidae	<i>Limnodromus griseus</i>	Short-billed Dowitcher	5
Charadriiformes	Scolopacidae	<i>Limnodromus scolopaceus</i>	Long-billed Dowitcher	1
Charadriiformes	Scolopacidae	<i>Limosa fedoa</i>	Marbled Godwit	16
Charadriiformes	Scolopacidae	<i>Numenius americanus</i>	Long-billed Curlew	2
Charadriiformes	Scolopacidae	<i>Numenius phaeopus</i>	Whimbrel	1
Charadriiformes	Scolopacidae	<i>Phalaropus fulicarius</i>	Red Phalarope	2
Charadriiformes	Scolopacidae	<i>Tringa flavipes</i>	Lesser Yellowlegs	1
Charadriiformes	Scolopacidae	<i>Tringa melanoleuca</i>	Greater Yellowlegs	5
Gruiformes	Rallidae	<i>Fulica americana</i>	American Coot	8
Passeriformes	Emberizidae	<i>Passerculus sandwichensis</i>	Savannah Sparrow	2
Pelecaniformes	Ardeidae	<i>Butorides virescens</i>	Green Heron	1
Pelecaniformes	Ardeidae	<i>Ardea alba</i>	Great Egret	2
Pelecaniformes	Ardeidae	<i>Egretta thula</i>	Snowy Egret	5
Podicipediformes	Podicipedidae	<i>Aechmophorus clarkii</i>	Clarke's Grebe	2
Podicipediformes	Podicipedidae	<i>Aechmophorus occidentalis</i>	Western Grebe	4
Podicipediformes	Podicipedidae	<i>Podiceps nigricollis</i>	Eared Grebe	13
Suliformes	Phalacrocoracidae	<i>Phalacrocorax auritus</i>	Double-crested Cormorant	6

Table S2. Slope estimates from analyses of the mean response treating individual birds as independent data points and those analyses where individuals were nested in a taxonomic hierarchy. Note: the bolded “y” and “n” represent the most appropriate tests for the studied bird ectoparasites.

Response variable	Analysis	log Mh slope	Lower 95% CL	Upper 95% CL	<u>Includes prediction for</u>	
					Surface users?	Volume users?
Log F_p	individuals independent	0.30	0.17	0.42	y	n
	with taxonomic hierarchy	0.26	-0.16	0.69	y	n
Log W_p	individuals independent	0.42	0.28	0.54	n	n
	with taxonomic hierarchy	0.34	-0.12	0.81	y	n

Table S3. Variance component estimates (REML) from analyses incorporating the taxonomic hierarchy as nested, random factors.

Response Variable	Random effect	Variance component	Standard error	Lower 95% CL	Upper 95% CL	Wald p-value	% of total
Log F_p	Order	0.11	0.18	-0.24	0.46	0.53	18.8
	Family	0.06	0.11	-0.16	0.27	0.60	9.7
	Genus	0.08	0.08	-0.08	0.23	0.34	13.1
	Species	0.10	0.07	-0.03	0.23	0.13	17.0
	Residual	0.24	0.02	0.20	0.29	0.00	41.4
Log W_p	Order	0.05	0.17	-0.27	0.38	0.75	8.4
	Family	0.08	0.14	-0.19	0.36	0.54	13.5
	Genus	0.09	0.09	-0.10	0.27	0.35	13.6
	Species	0.12	0.08	-0.04	0.27	0.13	18.9
	Residual	0.29	0.03	0.24	0.35	0.00	45.5

Table S4. Column header information for Dataset S1.

Column Header	Column Description
BirdSpecies	Nominal variable indicating bird host species (Latin binomial).
BirdID	Nominal variable (expressed as number) serving as a unique identifier for each bird host individual in this dataset
Mh	Numerical variable representing the body mass of bird host, in grams
Fp.tot	Numerical variable representing the estimated total ectoparasite energy-flux on bird host, in watts.
Wp.tot	Numerical variable representing the total ectoparasite biomass on bird host, in grams.
$W_{tot} * i * e^{E/kT} / (\text{meanMp}^{.25})$	Numerical variable representing the total ectoparasite biomass adjusted for parasite metabolic-rate. Units are watts, as the i normalization constant is $\text{watts/g}^{3/4}$.
Np.tot	Numerical variable representing the total ectoparasite numbers on bird host.
MeanMp	Numerical variable representing the mean parasite body size, in grams, on a host.
$\text{MeanMp}^{.25}$	Numerical variable representing the mean parasite body size $^{3/4}$, in $\text{grams}^{3/4}$, on a host.

Table S5. Column header information for Dataset S2.

Column Header	Column Description
BirdSpecies	Nominal variable indicating bird host species (Latin binomial).
BirdID	Nominal variable (expressed as number) serving as a unique identifier for each bird host individual
Mh	Numerical variable representing the body mass of bird host, in grams
Mite/Louse	Nominal variable indicating whether parasite variables are for aggregated mites or aggregated lice.
MeanMp	Numerical variable representing the mean parasite body size, in grams, on a host.
Fp.tot	Numerical variable representing the total mite or louse energy-flux on bird host, in watts.
Wp.tot	Numerical variable representing the total mite or louse biomass on bird host, in grams.
Np.tot	Numerical variable representing the total mite or louse numbers on bird host.

Dataset S1. (Separate file)

This is a comma-delimited ASCII text file entitled “DataS1-IndivBirdParasiteLoad.csv”, which includes the data underlying **Figs. 1, 2, 3, and S1**.

Dataset S2. (Separate file)

This is a comma-delimited ASCII text file entitled “DataS2-IndivBirdParasiteLoad-Mites&Lice.csv”, which includes the data underlying **Figs. 4 and S2**.