Supplement to Stanger-Hall et al.

SUPPLEMENT PART I: OVERVIEW

Supplement 1: Hypotheses

Table S1: Hypotheses and predictions on male (M) and female (F) eye and antenna size in nocturnal (N) and diurnal (D) firefly species. *Eye Size*: (i) Nocturnal males, who navigate in low ambient light conditions (dusk or night), will have relatively larger eyes than diurnal males who navigate in day-time environments; (ii) Regardless of primary signal mode (light or pheromones), males will have relatively larger eyes than females, because they fly through their nocturnal or diurnal habitat looking for stationary females. *Antenna Size*: (iii) Diurnal males will have relatively larger antennae for enhanced pheromone detection than nocturnal males, and (iv) diurnal males (pheromone receivers) will have larger antennae than their conspecific females (pheromone senders). (v) For nocturnal species, antenna size will be similar in males and females because light, and not pheromones, is the primary signal mode. *Note*: [a] retained use of pheromones or antennae used mainly by males to sample cuticular hydrocarbons (CHC);
[b] pheromones no longer being used or antenna equally important for males and females to sample CHC (or close-distance pheromones).

Firefly Activity	Light Levels & **Signal Mode**	**Mate Search Behavior**		**Hypotheses for Sensor Size Evolution**	**Predicted**	
		Males	**Females**		**Eyes**	**Antennae**
Day	Higher Light Levels	Navigation: Actively Searching	Sedentary	**H1**: Visual Navigation	M > F	
	Pheromones	Locating Female: Tracking Pheromones	Emitting Pheromones	**H3**: Detection and Tracking of Female Pheromones		M > F
Dusk/ Night	Lower Light Levels	Navigation: Actively Searching	Sedentary	**H1**: Visual Navigation	M > F	
	Light Signals	Emitting Light Signals Searching for Female Light Response	Detecting Male Light Signals Responding to Male Light Signal	**H2**: Detection of Male and Female Light Signals	M = F	*Note*: M > F[a] or M = F[b]
COMPARISON BY ACTIVITY TIME: Diurnal (D) with Pheromones only versus Nocturnal (N) with Light signals.				**H1**: (M and F) **H2**: (M and F) **H3**: (M only)	N > D N > D	 D > N

Supplement 2: Methods & Data Sets

Specimen collection, identification & morphological measurements. All specimens were collected from natural populations, preserved in 95% ethanol, and kept at -80°C until measurements were made. Specimens were identified to species using flash pattern, morphology (Fender 1966; Green 1957; Green 1956; Luk *et al*. 2011) and 376 bp of the mitochondrial COI locus, previously shown to be diagnostic to species in *Photinus* fireflies (Stanger-Hall *et al*. 2007). Specimens used in this study are part of the permanent KSH collection at the University of Georgia. Where possible, measures were obtained from at least 3 males and 3 females per species. For specific photographs (1 mm grid not in focus), the scale was extrapolated from the more inclusive photos using the pixel to distance (mm) ratio of two landmarks that could be visualized in both the specific and inclusive views. Area measurements were made by tracing the respective morphological shape in ImageJ v.1.42 (Schneider *et al*. 2012) and calculating the area.

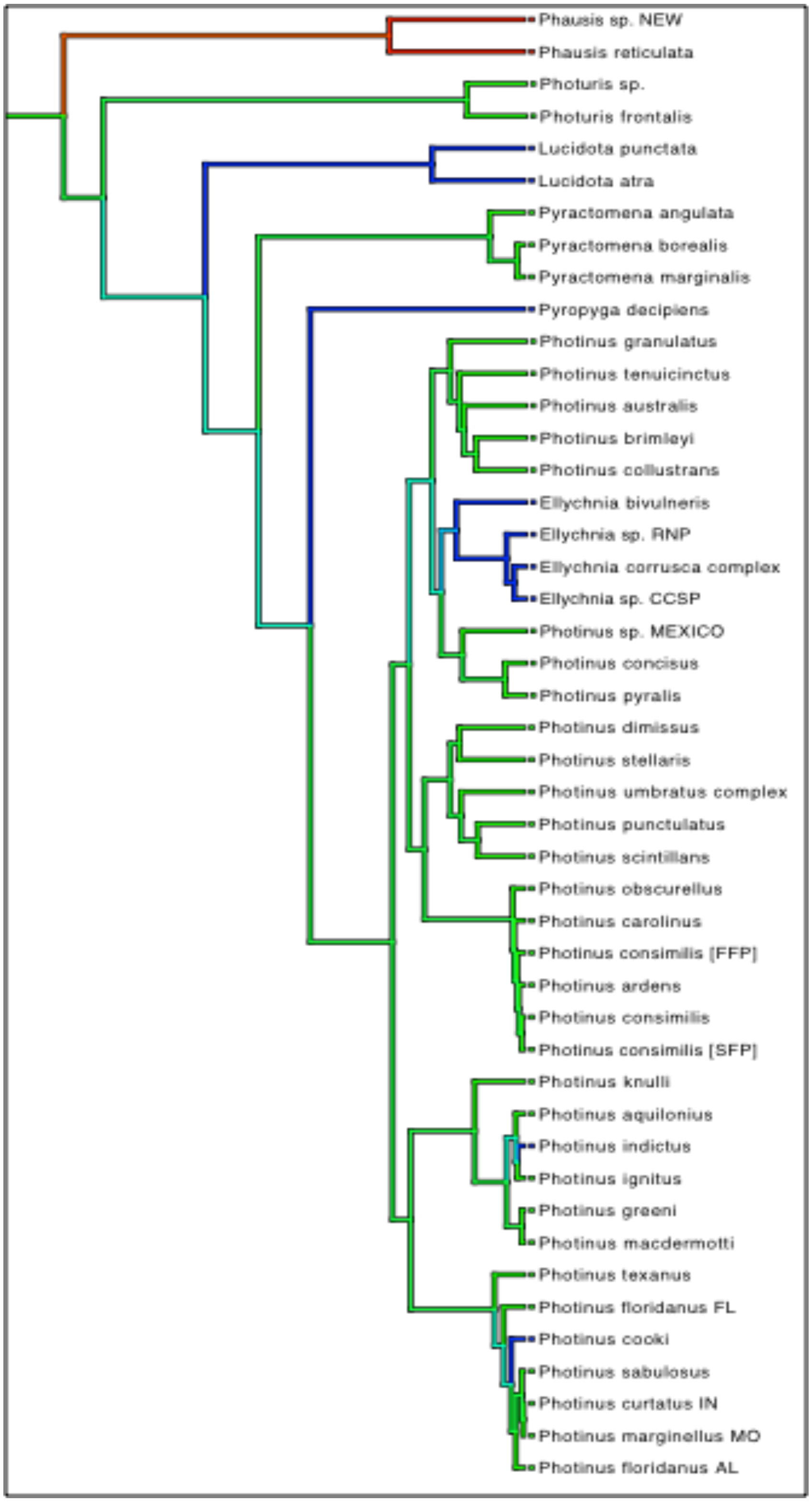
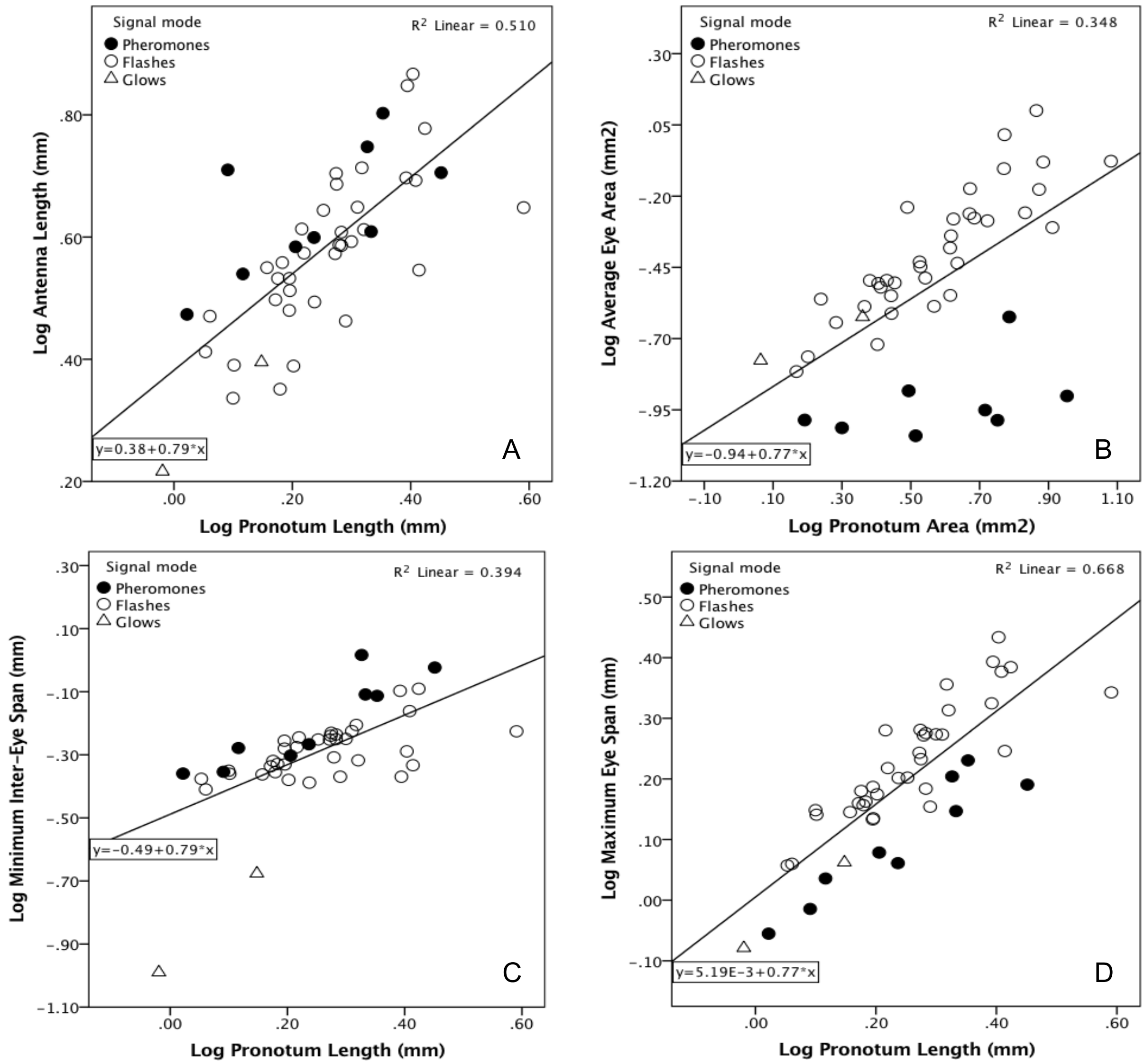


Fig. S1. **Phylogenetic relationships of the 46 NA taxa in this study**. We used our existing molecular phylogeny constructed from one mitochondrial (*COI*) and two nuclear loci (*CAD*, *WG*) from 76 North American taxa (Stanger-Hall and Lloyd 2015 and Sander and Hall 2016 Suppl. for more details) in our phylogeny-based analyses. For the present study, the phylogenetic tree was trimmed to include only the 46 taxa used in the analysis. Branch lengths reflect the amount of evolutionary change along the branches (branch lengths represent relative change). Shading indicates signal mode: blue=pheromones only, green=flashes, red=glows. Three independent light signal losses occurred within the *Photinus* clade: *Photinus indictus and P. cooki* and the common ancestor of *Ellychnia (nests within Photinus: Stanger-Hall and Lloyd 2015).* Abbreviations: RNP = Redwood National Park, CCSP = Castle Crags State Park, FL = Florida, AL=Alabama, IN = Indiana, MO = Missouri, [FFP]=fast-fast pulse variant, [SFP]= slow-fast pulse variant.



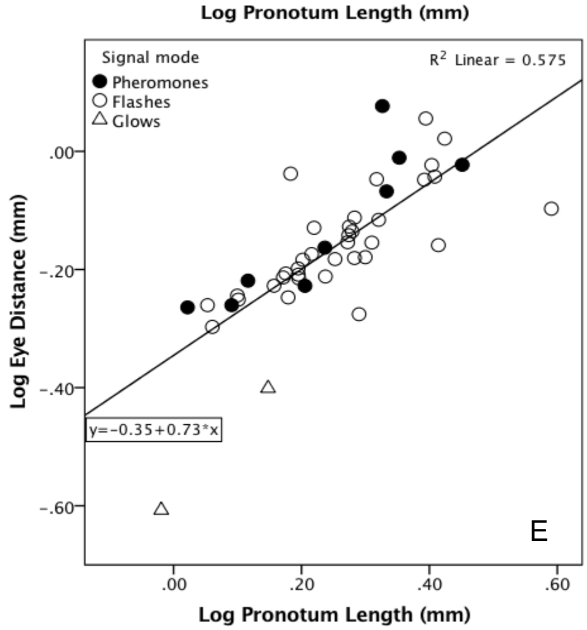


Fig. S2. Male sensor morphology of North American fireflies by sexual signal mode (N= 46 taxa). Nocturnal fireflies are shown in white (flash: N=35) and gray (glow: N=2). Diurnal (dark/unlighted=pheromones) fireflies are marked by solid black circles (N= 9). A: antenna size, B: eye size, C: min. eye span, D: max. eye span, E: eye distance. The residuals of these variables were submitted to a phylogenetic analysis: both antenna length and eye area were associated with signal mode (light or pheromones). The change in eye area (B) was mostly due to a change in maximum eye span (D).

Table S2: Male Sensor morphology of 46 North American taxa. Abbreviations: RNP = Redwood National Park, CCSP = Castle Crags State Park, FL = Florida, AL=Alabama, IN = Indiana, MO = Missouri, [FFP]=fast-fast pulse variant, [SFP]= slow-fast pulse variant.

Male Morphology [mm or mm^2]			Signal mode		Pronotum		Antenna	Eye (mm^2 or mm)			
Genus	**Species**	**N**	**0-Dark 1-Light**	**0-Dark 1-Flash 2-Glow**	**Area (mm^2)**	**Length (mm)**	**Length (mm)**	**Average Eye Area**	**Eye Distance**	**Max Eye Span**	**Min Eye Span**
Ellychnia	bivulneris	3	0	0	3.266	1.724	3.974	.091	.687	1.151	.541
Ellychnia	CCSP	1	0	0	8.989	2.827	5.074	.126	.949	1.551	.948
Ellychnia	corrusca cplx	5	0	0	5.648	2.153	4.063	.103	.856	1.403	.779
Ellychnia	RNP	1	0	0	5.197	2.121	5.593	.112	1.193	1.600	1.039
Lucidota	atra	3	0	0	6.110	2.254	6.347	.238	.975	1.701	.771
Lucidota	punctata	3	0	0	1.555	1.233	5.128	.103	.549	.967	.443
Phausis	NEW	3	1	2	1.158	.956	1.646	.167	.247	.834	.102
Phausis	reticulata	5	1	2	2.291	1.405	2.485	.238	.397	1.154	.211
Photinus	aquilonius	2	1	1	2.530	1.566	3.020	.190	.634	1.359	.556
Photinus	ardens	3	1	1	5.280	2.042	4.454	.517	.701	1.876	.596
Photinus	australis	3	1	1	4.206	1.902	3.865	.525	.732	1.870	.492
Photinus	brimleyi	3	1	1	4.700	2.093	4.094	.670	.766	2.057	.481
Photinus	carolinus	3	1	1	5.896	2.077	5.168	.788	.897	2.269	.623
Photinus	collustrans	3	1	1	2.405	1.511	2.244	.319	.566	1.435	.441
Photinus	concisus	3	1	1	6.793	2.466	4.975	.552	.895	2.112	.800
Photinus	consimilis	4	1	1	4.836	1.879	5.060	.528	.721	1.910	.576
Photinus	consimilis FFP	1	1	1	3.090	1.644	4.104	.576	.670	1.906	.530
Photinus	consimilis SFP	1	1	1	4.684	1.994	3.914	.548	.662	1.878	.563
Photinus	cooki	3	0	0	1.996	1.307	3.464	.097	.604	1.086	.527
Photinus	curtatus	6	1	1	2.772	1.524	3.616	.282	.917	1.454	.469
Photinus	dimissus	5	1	1	1.734	1.258	2.169	.275	.570	1.407	.446
Photinus	floridanus FL	4	1	1	1.590	1.150	2.954	.172	.505	1.148	.389
Photinus	floridanus AL	4	1	1	1.472	1.130	2.583	.153	.549	1.141	.421
Photinus	granulatus	3	1	1	2.693	1.592	2.449	.320	.655	1.495	.417
Photinus	greeni	3	1	1	4.319	1.882	4.858	.367	.746	1.709	.588
Photinus	ignitus	5	1	1	3.485	1.788	4.404	.326	.657	1.593	.561

Photinus	indictus	3	0	0	3.118	1.605	3.838	.131	.592	1.198	.498
Photinus	knulli	2	1	1	3.354	1.728	3.117	.371	.614	1.591	.409
Photinus	macdermotti	6	1	1	4.119	1.918	4.055	.283	.660	1.527	.562
Photinus	marginellus	3	1	1	2.779	1.569	3.253	.245	.610	1.365	.467
Photinus	[Mexico]	2	1	1	4.112	1.872	3.740	.415	.702	1.751	.560
Photinus	obscurellus	3	1	1	3.372	1.658	3.747	.357	.742	1.651	.569
Photinus	punctulatus	2	1	1	4.139	1.919	3.856	.458	.773	1.886	.582
Photinus	pyralis	4	1	1	7.460	2.654	5.993	.666	1.051	2.423	.812
Photinus	sabulosus	3	1	1	2.320	1.436	3.547	.259	.592	1.397	.434
Photinus	scintillans	4	1	1	2.840	1.498	3.406	.313	.621	1.514	.480
Photinus	stellaris	3	1	1	1.918	1.263	2.457	.227	.561	1.383	.436
Photinus	tenuicinctus	4	1	1	7.667	2.561	4.928	.831	.906	2.382	.690
Photinus	texanus	5	1	1	2.586	1.567	3.407	.302	.618	1.537	.525
Photinus	umbratus	3	1	1	2.543	1.484	3.143	.312	.612	1.446	.461
Photuris	frontalis	3	1	1	7.323	2.533	7.359	1.261	.948	2.715	.514
Photuris	species	2	1	1	5.919	2.479	7.044	1.037	1.137	2.473	.427
Pyractomena	angulata	3	1	1	8.154	2.594	3.515	.490	.694	1.762	.464
Pyractomena	borealis	3	1	1	12.061	3.897	4.449	.837	.800	2.201	.595
Pyractomena	marginalis	1	1	1	3.695	1.950	2.901	.259	.530	1.426	.427
Pyropyga	decipiens	3	0	0	1.400	1.052	2.974	.050	.544	.881	.437

Table S3: Female Sensor morphology of 18 North American taxa. For species abbreviations please see Fig. S1 and Table S2 legends.

Female Morphology			**Signal mode**		**Pronotum**		**Antenna**	**Eye (mm^2 or mm)**			
Genus	**Species**	**N**	**0-Dark 1-Light**	**0-Dark 1-Flash 2-Glow**	**Area (mm^2)**	**Length (mm)**	**Length (mm)**	**Average Eye Area**	**Eye Distance**	**Max Eye Span**	**Min Eye Span**
Ellychnia	ACRP	1	0	0	11.676	2.988	6.225	0.151	0.882	1.689	0.771
Ellychnia	bivulneris	1	0	0	3.043	1.616	3.715	0.097	0.643	1.194	0.564
Ellychnia	californica	1	0	0	8.045	2.440	4.489	0.193	1.085	1.664	0.998
Ellychnia	corrusca cplx	3	0	0	8.557	2.509	4.257	0.122	0.771	1.572	0.962
Ellychnia	RNP	1	0	0	10.734	3.025	6.074	0.115	1.209	1.711	1.201
Lucidota	atra	3	0	0	9.293	2.723	6.404	0.237	0.908	1.781	0.785
Photinus	aquilonius	1	1	1	2.053	1.269	3.186	0.179	0.645	1.226	0.470
Photinus	australis	3	1	1	3.170	1.623	3.497	0.207	0.589	1.357	0.539
Photinus	carolinus	3	1	1	8.016	2.322	5.014	0.345	0.904	1.842	0.651
Photinus	curtatus	3	1	1	2.407	1.515	2.776	0.123	0.636	1.130	0.523
Photinus	cooki	3	0	0	2.338	1.476	3.520	0.101	0.573	1.102	0.521
Photinus	indictus	2	0	0	3.735	1.748	3.862	0.091	0.735	1.149	0.608
Photinus	macdermotti	4	1	1	5.460	2.130	4.440	0.248	0.779	1.561	0.598
Photinus	marginellus	4	1	1	2.744	1.507	3.231	0.154	0.655	1.272	0.558
Photinus	pyralis	4	1	1	7.624	2.501	5.430	0.292	1.000	1.856	0.881
Photinus	scintillans	3	1	1	2.396	1.353	2.196	0.137	0.557	1.115	0.407
Pyractomena	borealis	1	1	1	13.341	3.434		0.379	0.904	1.850	0.645
Pyropyga	decipiens	3	0	0	2.102	1.239	2.876	0.038	0.672	0.878	0.573

Table S4: Worldwide data on male sensor morphology: Revised genus names (Ohba 1978): ***Pyrocoelia**** *(Lychnuris)*, ***Medeopteryx**** (*Pteroptyx*), ***Pygatyphella**** (*Luciola*), ***Aquatica***** (*Luciola*), and ***Luciola****** (*Hotaria*): L. Ballantyne personal communication.

Ohba adj: For the combined analysis Ohba's antenna measures were adjusted (see Suppl. Part 4 below).

International Data Set				Signal mode & signal types			International Comparison		
Male Morphology				Levels of Analysis (signal modes and types within mode)			Ohba Fig.1 (calc. for NA)		Ohba Fig.3 (calc. for NA)
Genus	Species	Data set	N	0-Dark 1-Light	0-Dark 1-Flash 2-Glow	0-Dark 1-Flash 2-Glow 3-Weak glow 4-Light loss	Eye Width / Pronotum Length (e/p)	Log e/p	Log Antenna Size / Pronotum Length Log a/p [Ohba adj]
Ellychnia	bivulneris	ksh-1	3	0	0	4	.1768	-.752	.360
Ellychnia	CCSP	ksh-1	1	0	0	4	.1067	-.972	.250
Ellychnia	corrusca cplx	ksh-1	5	0	0	4	.1449	-.839	.280
Ellychnia	RNP	ksh-1	1	0	0	4	.1322	-.879	.420
Lucidota	atra	ksh-1	3	0	0	0	.2063	-.686	.450
Lucidota	punctata	ksh-1	3	0	0	0	.2128	-.672	.620
Phausis	NEW	ksh-1	3	1	2	2	.3825	-.417	.240
Phausis	reticulata	ksh-1	5	1	2	2	.3356	-.474	.250
Photinus	aquilonius	ksh-1	2	1	1	1	.2565	-.591	.290
Photinus	ardens	ksh-1	3	1	1	1	.3134	-.504	.340
Photinus	australis	ksh-1	3	1	1	1	.3622	-.441	.310
Photinus	brimleyi	ksh-1	3	1	1	1	.3766	-.424	.290
Photinus	carolinus	ksh-1	3	1	1	1	.3962	-.402	.400
Photinus	collustrans	ksh-1	3	1	1	1	.3288	-.483	.170
Photinus	concisus	ksh-1	3	1	1	1	.2660	-.575	.300
Photinus	consimilis	ksh-1	4	1	1	1	.3548	-.450	.430
Photinus	consimilis FFP	ksh-1	1	1	1	1	.4185	-.378	.400
Photinus	consimilis SFP	ksh-1	1	1	1	1	.3297	-.482	.290

Photinus	cooki	ksh-1	3	0	0	4	.2139	-.670	.420
Photinus	curtatus	ksh-1	6	1	1	1	.3233	-.490	.380
Photinus	dimissus	ksh-1	5	1	1	1	.3821	-.418	.240
Photinus	floridanus FL	ksh-1	4	1	1	1	.3278	-.484	.410
Photinus	floridanus AL	ksh-1	4	1	1	1	.3187	-.497	.360
Photinus	granulatus	ksh-1	3	1	1	1	.3385	-.470	.190
Photinus	greeni	ksh-1	3	1	1	1	.2976	-.526	.410
Photinus	ignitus	ksh-1	5	1	1	1	.2886	-.540	.390
Photinus	indictus	ksh-1	3	0	0	4	.2181	-.661	.380
Photinus	knulli	ksh-1	2	1	1	1	.3420	-.466	.260
Photinus	macdermotti	ksh-1	6	1	1	1	.2517	-.599	.330
Photinus	marginellus	ksh-1	3	1	1	1	.2861	-.544	.320
Photinus	[Mexico]	ksh-1	2	1	1	1	.3181	-.497	.300
Photinus	obscurellus	ksh-1	3	1	1	1	.3263	-.486	.350
Photinus	punctulatus	ksh-1	2	1	1	1	.3400	-.469	.300
Photinus	pyralis	ksh-1	4	1	1	1	.3036	-.518	.350
Photinus	sabulosus	ksh-1	3	1	1	1	.3354	-.474	.390
Photinus	scintillans	ksh-1	4	1	1	1	.3453	-.462	.360
Photinus	stellaris	ksh-1	3	1	1	1	.3749	-.426	.290
Photinus	tenuicinctus	ksh-1	4	1	1	1	.3304	-.481	.280
Photinus	texanus	ksh-1	5	1	1	1	.3231	-.491	.340
Photinus	umbratus	ksh-1	3	1	1	1	.3318	-.479	.330
Photuris	frontalis	ksh-1	3	1	1	1	.4344	-.362	.460
Photuris	species	ksh-1	2	1	1	1	.4127	-.384	.450
Pyractomena	angulata	ksh-1	3	1	1	1	.2502	-.602	.130
Pyractomena	borealis	ksh-1	3	1	1	1	.2061	-.686	.060
Pyractomena	marginalis	ksh-1	1	1	1	1	.2562	-.591	.170
Pyropyga	decipiens	ksh-1	3	0	0	0	.2109	-.676	.450
Bicellonycha	wickershamorum	ksh-2	1	1	1	1	.5487	-.261	.360
Brachylampis	saguinicollis	ksh-2	1	0	0	0	.3321	-.479	.590

Diaphanes	formosus	ksh-2	1	1	2	2	.6242	-.205	.250
Ellychnia	corrusca complex	ksh-2	1	0	0	0	.2184	-.661	.280
Lamprohiza	splendidula	ksh-2	1	1	2	2	.5064	-.295	-.790
Lampyris	noctiluca	ksh-2	1	1	2	2	.6120	-.213	.280
Lucidina	biplagiata	ksh-2	1	0	0	0	.2161	-.665	.730
Lucidota	punctata	ksh-2	1	0	0	0	.2214	-.655	.700
Luciola	cerata	ksh-2	1	1	1	1	.8782	-.056	.560
Lychnuris	formosana	ksh-2	1	1	2	3	.2537	-.596	.520
Micronaspis	floridana	ksh-2	1	1	1	1	.5898	-.229	.300
Microphotus	angustus	ksh-2	1	1	2	2	.4409	-.356	-.090
Paraphausis	eximia	ksh-2	1	1	2	2	.2401	-.620	.200
Phosphaenus	hemipterus	ksh-2	1	0	0	0	.1212	-.916	.360
Photinus	brimleyi	ksh-2	1	1	1	1	.3796	-.421	.220
Photuris	hebes	ksh-2	1	1	1	1	.5946	-.226	.500
Photuris	LIV (Lloyd)	ksh-2	1	1	1	1	.5042	-.297	.520
Photuris	lucicrescens	ksh-2	1	1	1	1	.5711	-.243	.470
Photuris	MG (Lloyd)	ksh-2	1	1	1	1	.6597	-.181	.680
Pleotomus	pallens	ksh-2	1	1	2	2	.6116	-.214	.320
Pollaclasis	bifaria	ksh-2	1	0	0	0	.2680	-.572	.560
Pyropyga	nigricans	ksh-2	1	0	0	0	.3601	-.444	.420
Brachylampis	saguinicollis	ohba	1	0	0	0	.3065	-.514	1.05 [.4410]
Curtos	costipennis	ohba	1	1	1	1	.7258	-.139	
Curtos	okinawanus	ohba	1	1	1	1	.8306	-.081	.630 [.2646]
Cyphonocerus	marginatus	ohba	1	1	2	3	.2742	-.562	1.58 [.6636
Cyphonocerus	ruficollis	ohba	5	1	2	3	.2903	-.537	1.13 [.4746]
Drilaster	bicolor	ohba	1	0	0	0	.2097	-.678	.890 [.3738]
Ellychnia	californica	ohba	1	0	0	0	.1452	-.838	1.05 [.4410]
Luciola*****	parvula	ohba	5	1	1	1	.7742	-.111	.580 [.2436]
Lamprohiza	splendidula	ohba	1	1	2	2	.4839	-.315	.430 [.1806]

Lampyris	noctiluca	ohba	1	1	2	2	.4194	-.377	.470 [.1989]
Lucidina	accensa	ohba	5	0	0	0	.1613	-.792	1.71 [.7182]
Lucidina	biplagiata	ohba	4	0	0	0	.2097	-.678	1.53 [.6426]
Lucidina	okadai	ohba	1	0	0	0	.1935	-.713	.610 [.2562]
Luciola	cruciata	ohba	5	1	1	1	.6935	-.159	.450 [.1890]
Luciola	filiformis yayeyamana	ohba	1	1	1	1	.9677	-.014	.610 [.2562]
Luciola	kuroiwae	ohba	1	1	1	1	.6290	-.201	.290 [.1218]
Aquatica****	lateralis	ohba	5	1	1	1	.7419	-.130	.790 [.3318]
Pygatyphella***	obsoleta	ohba	5	1	1	1	.6774	-.169	.530[.2226]
Micronaspis	floridana	ohba	1	1	1	1	.3548	-.450	.550[.2310]
Photinus	ardens	ohba	1	1	1	1	.4839	-.315	.890 [.3738]
Photinus	pyralis	ohba	1	1	1	1	.4355	-.361	.870 [.3654]
Photuris	congener	ohba	1	1	1	1	.5806	-.236	.680 [.2856]
Photuris	flavicollis	ohba	1	1	1	1	.5323	-.274	.820 [.3444]
Pleotomus	pallens	ohba	1	1	2	2	.4032	-.394	.820 [.3444]
Pollaclassis	bifaria	ohba	1	0	0	0	.3387	-.470	1.58 [.6636]
Pristolycus	sagulatus	ohba	1	0	0	0	.2419	-.616	1.50 [.6300]
Pristolycus	shikokensis	ohba	1	0	0	0	.3065	-.514	1.37 [.5754]
Pteroptyx	amilae	ohba	1	1	1	1	.7419	-.130	.870 [.3654]
Medeopteryx**	cribellata	ohba	1	1	1	1	.6290	-.201	.630 [.2646]
Pterotus	obscuripennis	ohba	1	0	0	0	.3387	-.470	
Pyractomena	borealis	ohba	1	1	1	1	.3387	-.470	.390 [.1638]
Pyractomena	marginalis	ohba	1	1	1	1	.3226	-.491	.390 [.1638]
Pyractonema	nigripennis	ohba	1	0	0	0	.2097	-.678	1.50 [.6300]
Pyrocoelia*	abdominalis	ohba	1	1	2	3			1.21 [.5084]
Pyrocoelia*	atripennis	ohba	1	1	2	3	.2581	-.588	1.50 [.6300]
Pyrocoelia*	discicollis	ohba	5	1	2	3	.1613	-.792	1.24 [.5195]
Pyrocoelia*	fumosa	ohba	1	1	2	3	.2097	-.678	

Pyrocoelia*	matsumurai kumejimensis	ohba	1	1	2	3	.1613	-.792	1.21[.5084]
Pyrocoelia*	rufa	ohba	1	1	2	2	.4516	-.345	1.21 [.5084]
Pyropyga	nigricans	ohba	1	0	0	0	.1935	-.713	1.00 [.4200]
Vesta	proxma	ohba	1	0	0	0	.2258	-.646	1.76 [.7392]

Table S5: Worldwide data on sensor morphology of male-female pairs. For the combined analysis Ohba's antenna measures were adjusted (see Suppl. Part 4 below). Signal mode: 3 independent events of light loss: 2^A, 2^B, 2^C. For species abbreviations please see Fig. S1 and Table S2 legends; * revised genera (since Ohba 1978: see Table S4).

International Data Set: Male and Female Pairs					Signal Mode		Eye [mm]	Antenna [mm]
Genus	**Species**	**Data set**	**Sex**	**N**	**0-Dark 1-Light**	**0-Dark 1-Light 2-Light Loss**	**Log Eye Width/ Pronotum Length**	**Log Antenna Size/ Pronotum Length [Ohba adjusted]**
Ellychnia	bivulneris	ksh	f	1	0	2^A	-.7101	.3615
Ellychnia	bivulneris	ksh	m	3	0	2^A	-.7525	.3627
Ellychnia	corrusca	ksh	f	3	0	2^A	-.9153	.2295
Ellychnia	corrusca	ksh	m	5	0	2^A	-.8390	.2759
Ellychnia	sp. RNP	ksh	f	1	0	2^A	-1.0742	.3027
Ellychnia	sp. RNP	ksh	m	1	0	2^A	-.8786	.4211
Lucidota	atra	ksh	f	3	0	0	-.7379	.3714
Lucidota	atra	ksh	m	3	0	0	-.6856	.4497
Photinus	aquilonius	ksh	f	1	1	1	-.5260	.3998
Photinus	aquilonius	ksh	m	2	1	1	-.5908	.2851
Photinus	australis	ksh	f	3	1	1	-.5989	.3333
Photinus	australis	ksh	m	3	1	1	-.4411	.3079
Photinus	carolinus	ksh	f	3	1	1	-.5913	.3343
Photinus	carolinus	ksh	m	3	1	1	-.4021	.3959
Photinus	cooki	ksh	f	3	0	2^B	-.7058	.3776
Photinus	cooki	ksh	m	3	0	2^B	-.6697	.4232

Photinus	curtatus	ksh	f	3	1	1	-.6984	.2632
Photinus	curtatus	ksh	m	6	1	1	-.4904	.3752
Photinus	indictus	ksh	f	2	0	2^{C}	-.8102	.3444
Photinus	indictus	ksh	m	3	0	2^{C}	-.6613	.3787
Photinus	macdermotti	ksh	f	4	1	1	-.6458	.3190
Photinus	macdermotti	ksh	m	6	1	1	-.5991	.3252
Photinus	marginellus	ksh	f	4	1	1	-.6251	.3314
Photinus	marginellus	ksh	m	3	1	1	-.5435	.3167
Photinus	pyralis	ksh	f	4	1	1	-.7102	.3368
Photinus	pyralis	ksh	m	4	1	1	-.5178	.3537
Photinus	scintillans	ksh	f	3	1	1	-.5819	.2104
Photinus	scintillans	ksh	m	4	1	1	-.4618	.3567
Pyractomena	borealis	ksh	f	1	1	1	-.7558	
Pyractomena	borealis	ksh	m	4	1	1	-.6859	.0575
Pyropyga	decipiens	ksh	f	3	0	0	-.9099	.3656
Pyropyga	decipiens	ksh	m	3	0	0	-.6759	.4515
Cyphonocerus	ruficollis	ohba	f	5	1	1	-.7317	
Cyphonocerus	ruficollis	ohba	m	5	1	1	-.5372	1.1300 [.4746]
Luciola*****	parvula	ohba	f	1	1	1	-.4914	.3800 [.1596]
Luciola*****	parvula	ohba	m	5	1	1	-.1111	.5800 [.2436]
Lucidina	accensa	ohba	f	2	0	0	-.9795	1.2200 [.5124]
Lucidina	accensa	ohba	m	5	0	0	-.7924	1.7100 [.7182]
Lucidina	biplagiata	ohba	f	3	0	0	-.8893	1.1200 [.4704]
Lucidina	biplagiata	ohba	m	4	0	0	-.6784	1.5300 [.6426]

Luciola	cruciata	ohba	f	5	1	1	-.3010	
Luciola	cruciata	ohba	m	5	1	1	-.2013	.2900 [.1218]
Aquatica****	lateralis	ohba	f	5	1	1	-.2422	
Aquatica****	lateralis	ohba	m	5	1	1	-.1297	.7900 [.3318]
Pygatyphella***	obsoleta	ohba	f	5	1	1	-.3774	.4300 [.1806]
Pygatyphella***	obsoleta	ohba	m	5	1	1	-.1692	.5300 [.2226]
Pteroptyx	amilae	ohba	f	1	1	1	-.2872	.5000 [.2100]
Pteroptyx	amilae	ohba	m	1	1	1	-.1297	.8700 [.3654]
Pyrocoelia*	fumosa	ohba	f	1	1	1	-1.1392	
Pyrocoelia*	fumosa	ohba	m	5	1	1	-.6784	
Pyrocoelia*	rufa	ohba	f	1	1	1	-1.0934	
Pyrocoelia*	rufa	ohba	m	1	1	1	-.3452	1.2100 [.5082]

Supplement 3. Phylogeny-Based Analyses

3.1 Phylogenetic signal

We determined the phylogenetic signal for each trait on this phylogeny: Pagel's λ for continuous traits (Pagel 1999), and for signal mode (binary: dark/light; Fritz and Purvis 2010; using the phylo.d function and 1000 permutations in caper; Orme 2013). λ is used as a multiplier of the off-diagonal elements of the variance-covariance matrix of a trait given the phylogenetic relationships of the species. The maximum likelihood value of λ is calculated as the value that provides the best fit of the matrix to the actual data. The λ value ranges between 0 (independent evolution) and 1 (traits covary as predicted by a Brownian motion model of evolution on the phylogeny). In contrast, D compares the number of observed changes in the state of a binary categorical trait with the number expected under a Brownian motion model of evolution that produces the same number of species with each character state as the observed pattern (Fritz and Purvis 2010, Symonds and Elgar 2013). For D a value of 1 suggests independent evolution, whereas 0 suggests evolution based on the phylogeny.

Table S6. **Phylogenetic signals** for continuous (lambda) and binary (D) traits in our data set (Pagel 1999, Fritz and Purvis 2010). λ =0 and D=1: independent evolution

Trait	λ (continuous)	LRT p value	D (binary)
LogProL	0.87216	4.85E-05	
LogProA	0.87933	1.47E-04	
LogAntL	0.90969	2.34E-05	
LogAvgEyeA	0.92926	1.95E-05	
LogEyeDist	0.85471	1.21E-05	
LogMaxEyeSpan	0.92553	1.01E-05	
LogMinEyeSpan	0.99164	2.89E-12	
Signal mode [LD]			0.03313
Probability of E(D) with no phylogenetic structure: 0			
Probability of E(D) with Brownian phylogenetic structure: 0.477			

3.2 Phylogenetic Models & Analyses

To test for correlations between morphological and signal traits, while adjusting for phylogenetic covariance (Garland *et al.* 1992), we used *pGLS* in caper (Orme 2013). To determine the best model of character evolution for each log-transformed eye and antenna measure (response variables), we tested four models with two explanatory variables (body size: Log Pronotum Length and signal mode: LD) in R (with lambda, kappa, and delta = 1: Orme 2013).

Example Antenna Length:	(1) LogAntL~LD*LogProL	(2) LogAntL~LD+LogProL
	(3) LogAntL~LD	(4) LogAntL~1

We used the Aikake information criterium to identify the model with the best fit, which was then used for further analysis. The pGLS function incorporates the covariance between taxa into the calculation of estimated coefficients in a GLS model. This covariance matrix assumes a Brownian model of evolution along the branches of this phylogeny (λ=1). However, in contrast to individual traits, this model-based λ reflects the covariance of the residuals in the matrix, rather than the original trait values (Symonds and Blomberg 2014). Since not all variables necessarily correspond to this assumption, we used maximum likelihood to determine the optimal Pagel's λ for branch length transformation for the trait combination in the model to improve the fit of the model to the data (Orme 2013), while holding other parameters (kappa=1, delta=1) constant. We report confidence bounds on optimized λ (λopt)for each model. For each λopt we tested whether it was significantly different from $\lambda = 0$ and $\lambda = 1$ (Table S7).

Comparative analysis of lineages with recent light loss (N=3)

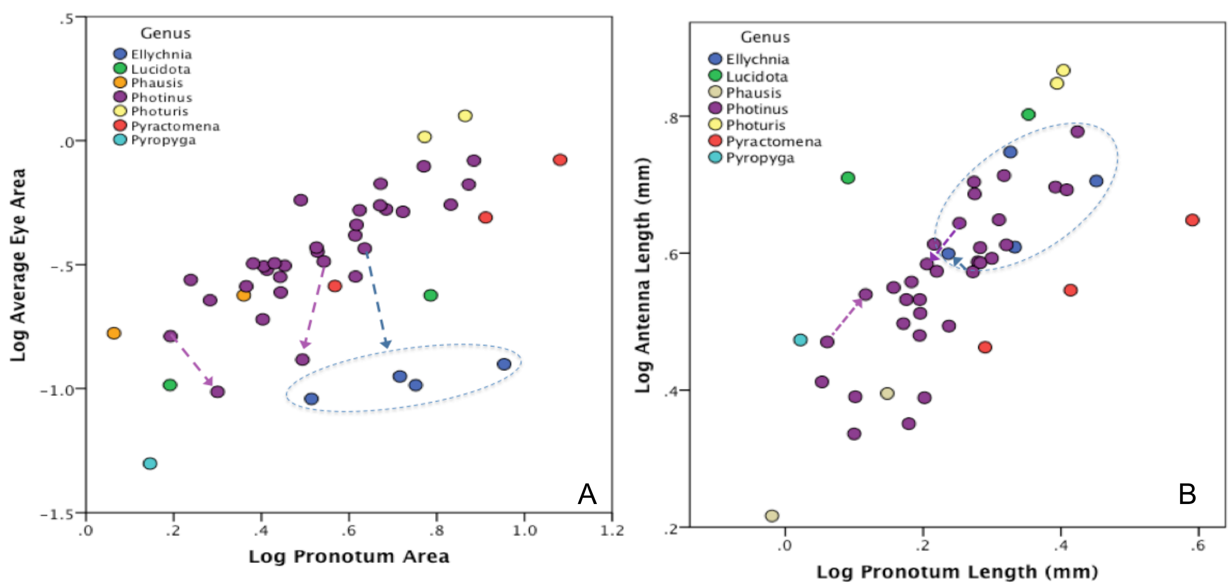


Fig. S3. Taxa with recent light loss (reversal to pheromones) and their closest relatives: A. Male eye area (mm^2) and B. Male antenna length (mm). The six taxa with recent light loss represent three independent samples (all 4 *Ellychnia species*: dark blue inside circle, *Photinus indictus* and *P. cooki*: purple). The arrows point from their respective closest nocturnal and light-emitting relatives to the species with recent light loss. The male eye size of the taxa with recent light loss falls within the distribution of the eye sizes of distantly related, diurnal taxa (A: *Pyropyga* in light blue, and *Lucidota* in green), rather than with their close relatives (*Photinus* in purple: connected by arrows). In contrast, male antenna sizes of the taxa with recent light loss group with the antenna sizes of their closest nocturnal relatives (B: *Photinus*).

Table S7: Best Models for Sensor Trait Evolution (PGLS): Eye size (LogAvgEyeA) and antenna size (LogAntL) are significantly correlated with environment/sexual signal used. LD (Light/Dark): nocturnal/light signal (L) versus diurnal/dark=pheromones (D). Subsequent analyses indicated that the change in eye size was driven by a change in maximum eye span (LogMaxEyeSpan), and that minimum inter-eye span (LogMin(Inter)EyeSpan) and eye distance (LogEyeDist) did not play a significant role.

Best Model: Eye Area	**Best Model: Antenna Length**	**Best Model: Eye Distance**	**Best Model: Maximum Eye Span**	**Best Model: Minimum Eye Span**
LogAvgEyeA ~ LD * LogProA	LogAntL ~ LD + LogProL	LogEyeDist ~ LD + LogProL	LogMaxEyeSpan ~ LD + LogProL	LogMinEyeSpan ~ LD + LogProL
Residuals:	Residuals:	Residuals:	Residuals:	Residuals:
Min 1Q Median 3Q Max	Min 1Q Median 3Q Max	Min 1Q Median 3Q Max	Min 1Q Median 3Q Max	Min 1Q Median 3Q Max
-0.36191 -0.12062 -0.01527 0.12489 0.60316	-0.33522 -0.10006 -0.00662 0.09821 0.41655	-0.33838 -0.06698 -0.00676 0.07592 0.28112	-0.12754 -0.02351 0.04668 0.09627 0.18139	-0.47319 -0.23125 -0.05485 0.07864 0.49441
Branch length transformations:	**Branch length transformations:**	**Branch length transformations:**	**Branch length transformations:**	**Branch length transformations:**
kappa [Fix] : 1.000; delta [Fix] : 1.000	kappa [Fix] : 1.000; delta [Fix] : 1.000	kappa [Fix] : 1.000; delta [Fix] : 1.000	kappa [Fix] : 1.000; delta [Fix] : 1.000	kappa [Fix] : 1.000; delta [Fix] : 1.000
lambda [ML] : 0.839	lambda [ML] : 0.859	lambda [ML] : 0.706	lambda [ML] : 0.832	lambda [ML] : 0.998
lower bound : 0.000, p = 2.2632e-05	lower bound : 0.000, p = 8.2596e-06	lower bound : 0.000, p = 3.8345e-05	lower bound : 0.000, p = 5.8597e-07	lower bound : 0.000, p = 1.4e-13
upper bound : 1.000, p = 4.5464e-09	upper bound : 1.000, p = 1.0525e-10	upper bound : 1.000, p = < 2.22e-16	upper bound : 1.000, p = 1.2405e-10	upper bound : 1.000, p = 0.65479
95.0% CI : (0.573, 0.948)	95.0% CI : (0.632, 0.954)	95.0% CI : (0.416, 0.877)	95.0% CI : (0.616, 0.941)	95.0% CI : (0.922, NA)
Coefficients:	**Coefficients:**	**Coefficients:**	**Coefficients:**	**Coefficients:**
Estimate Std. Error t value Pr(>|t|)	Estimate Std. Error t value Pr(>|t|)	Estimate Std. Error t value Pr(>|t|)	Estimate Std. Error t value Pr(>|t|)	Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.087925 0.103307 -10.5310 2.34e-13 ***	(Intercept) 0.433461 0.068282 6.3481 1.139e-07 ***	(Intercept) -0.362398 0.049073 -7.3849 3.582e-09 ***	(Intercept) -0.080869 0.034827 -2.3220 0.02504 *	(Intercept) -0.566096 0.090959 -6.2237 1.728e-07 ***
LD 0.238149 0.083238 2.8610 0.006554 **	LD -0.064011 0.029856 -2.1439 0.03773 *	LD -0.034133 0.025633 -1.3316 0.19 n.s.	LD 0.100559 0.015905 6.3225 1.241e-07 ***	LD -0.025539 0.021067 -1.2123 0.232 n.s.
LogProA 0.396903 0.131793 3.0116 0.004387 **	LogProL 0.839780 0.105980 7.9240 6.076e-10 ***	LogProL 0.725094 0.089740 8.0799 3.654e-10 ***	LogProL 0.731245 0.056266 12.9963 2.220e-16 ***	LogProL 0.562322 0.075464 7.4515 2.873e-09 ***
LD:LogProA 0.467546 0.148319 3.1523 0.002987 **				
Residual SE = 0.2159 (df=43)	Residual SE = 0.1682 (df=43)	Residual SE = 0.1201 (df=43)	Residual SE = 0.08554 (df=43)	Residual SE = 0.2337 (df=43)
Multiple R-squared: 0.8679, Adj. R-squared: 0.8585	Multiple R-squared: 0.6008, Adj. R-squared: 0.5822	Multiple R-squared: 0.6044, Adj. R-squared: 0.586	Multiple R-squared: 0.8405, Adj. R-squared: 0.833	Multiple R-squared: 0.5655, Adj. R-squared: 0.5453
F-statistic: 91.98 on 3 and 42 DF, p-value: < 2.2e-16	**F-statistic: 32.35 on 2 and 43 DF, p-value: 2.668e-09**	**F-statistic: 32.84 on 2 and 43 DF, p-value: 2.196e-09**	**F-statistic: 113.3 on 2 and 43 DF, p-value: < 2.2e-16**	**F-statistic: 27.98 on 2 and 43 DF, p-value: 1.65e-08**

Table S8: Test and Training taxa for phylogenetic flexible discriminant analysis. Based on 37 training taxa (flash: 29, glow: 2, pheromones: 6) and an optimized lambda, based on 1 body size and 5 sensor (size and shape) measures of λopt=0 (i.e. independent evolution). Under this model the discriminant analysis correctly assigned all 6 nocturnal (flashes) and 3 diurnal (pheromones) test taxa to their signal group. For species abbreviations please see Fig. S1 and Table S2 legends (MD = Maryland, TN = Tennessee).

Test taxa	**assigned (true)**	**predicted**	**P(flash)**	**P(glow)**	**P(pher)**	**DA1**	**DA2**
Ellychnia_sp._RNP	unknown (pher)	pheromones	0.00000	0.00000	1.00000	7.09303	3.09981
Photinus_concisus	unknown (flash)	flash	1.00000	0.00000	0.00000	-0.80981	2.76526
Photinus_granulatus	unknown (flash)	flash	1.00000	0.00000	0.00000	-2.08229	-0.01603
Photinus_obscurellus	unknown (flash)	flash	1.00000	0.00000	0.00000	-0.97433	1.74038
Photinus_consimilis_	unknown (flash)	flash	1.00000	0.00000	0.00000	-0.93072	0.99996
Photinus_aquilonius	unknown (flash)	flash	1.00000	0.00000	0.00002	0.86494	0.98724
Photinus_cooki	unknown (pher)	pheromones	0.00006	0.00000	1.00000	3.95364	0.61198
Photinus_floridanus_AL	unknown (flash)	flash	1.00000	0.00000	0.00000	0.29556	0.38587
Lucidota_atra	unknown (pher)	pheromones	0.00006	0.00000	1.00000	4.00751	1.94744
Training taxa	**true class**	**predicted**	**P(flash)**	**P(glow)**	**P(pher)**	**DA1**	**DA2**
Phausis_sp._NEW	glow	glow	0.00000	1.00000	0.00000	-1.08929	-9.24742
Phausis_reticulata	glow	glow	0.00000	1.00000	0.00000	-0.35014	-5.36118
Photuris_sp.	flash	flash	1.00000	0.00000	0.00000	-1.06095	-0.82533
Photuris_frontalis	flash	flash	1.00000	0.00000	0.00000	-1.66827	-0.53136
Pyractomena_marginalis	flash	flash	1.00000	0.00000	0.00000	0.28349	-1.73354
Pyractomena_borealis	flash	flash	1.00000	0.00000	0.00000	-1.94138	0.03804
Pyractomena_angulata	flash	flash	1.00000	0.00000	0.00000	-1.31640	-0.76713
Ellychnia_corrusca_cplx	pheromones	pheromones	0.00000	0.00000	1.00000	6.23135	0.88184
Ellychnia_sp._CCSP	pheromones	pheromones	0.00000	0.00000	1.00000	6.71582	1.54845
Ellychnia_bivulneris	pheromones	pheromones	0.00000	0.00000	1.00000	5.91325	-0.47643
Photinus_sp._MEXICO	flash	flash	1.00000	0.00000	0.00000	-1.18261	0.98867
Photinus_pyralis_MD	flash	flash	1.00000	0.00000	0.00000	-0.17644	2.32069
Photinus_australis	flash	flash	1.00000	0.00000	0.00000	-1.79393	0.24740
Photinus_collustrans	flash	flash	1.00000	0.00000	0.00000	-2.91282	0.53959
Photinus_brimleyi	flash	flash	1.00000	0.00000	0.00000	-2.20164	-0.18523
Photinus_tenuicinctus	flash	flash	1.00000	0.00000	0.00000	-2.23487	1.81553
Photinus_dimissus	flash	flash	1.00000	0.00000	0.00000	-2.64758	0.79683
Photinus_stellaris	flash	flash	1.00000	0.00000	0.00000	-0.87567	-0.15543
Photinus_umbratus_cplx	flash	flash	1.00000	0.00000	0.00000	-1.48468	0.76256
Photinus_scintillans	flash	flash	1.00000	0.00000	0.00000	-0.88808	0.50475
Photinus_punctulatus	flash	flash	1.00000	0.00000	0.00000	-1.22384	1.11426
Photinus_consimilis_[FFP]	flash	flash	1.00000	0.00000	0.00000	-2.45199	0.95041
Photinus_consimilis_[SFP]	flash	flash	1.00000	0.00000	0.00000	-2.10934	0.87168
Photinus_ardens	flash	flash	1.00000	0.00000	0.00000	-1.33815	1.16895
Photinus_carolinus_TN	flash	flash	1.00000	0.00000	0.00000	-2.29369	1.84298
Photinus_knulli	flash	flash	1.00000	0.00000	0.00000	-1.27212	-1.01399
Photinus_indictus	pheromones	pheromones	0.00013	0.00000	0.99987	3.77159	-0.51011
Photinus_ignitus	flash	flash	1.00000	0.00000	0.00000	0.32328	0.83242
Photinus_greeni	flash	flash	1.00000	0.00000	0.00000	0.39623	1.15969
Photinus_macdermotti	flash	flash	1.00000	0.00000	0.00001	0.75530	0.64193
Photinus_floridanus_FL	flash	flash	1.00000	0.00000	0.00000	0.39839	-0.36061
Photinus_marginellus MO	flash	flash	1.00000	0.00000	0.00000	-0.05594	0.35334
Photinus_curtatus_IN	flash	flash	1.00000	0.00000	0.00000	-0.48910	1.89219
Photinus_sabulosus	flash	flash	1.00000	0.00000	0.00000	0.12126	-0.23483
Photinus_texanus	flash	flash	1.00000	0.00000	0.00000	-0.61210	0.73685
Pyropyga_decipiens	pheromones	pheromones	0.00000	0.00000	1.00000	6.17883	-0.84169
Lucidota_punctata	pheromones	pheromones	0.00000	0.00000	1.00000	4.58225	0.23522

Supplement 4: Worldwide Diversity of eye and antenna sizes in fireflies

4.1 Calculating Ohba's (1978) measurements for all individuals

We calculated Ohba's eye width (e) as ½ (maximum eye span – minimum eye span) from our data, and then divided by pronotum length (p), resulting in Ohba's e/p measure. Subsequently we log-transformed all eye data (log e/p) for a log-log graphic representation of both the scaled eye and antenna measures for lighted (flash, glow, weak glow) and unlighted (dark=pheromones) fireflies. The combined worldwide data set included measurements of 11shared taxa between data sets). We used these 11 taxa to test for the combinability of the Ohba data with our measurements.

After calculating the two variables used by Ohba for all species (Table S4), there was no significant difference in scaled eye size (log e/p), but a significant difference in scaled antenna size (log a/p) measurements between the same eleven species in the two data sets, likely reflecting the difference in how antenna size was measured (our linear length measure versus Ohba's estimate of area (length x width) measure. To adjust for this difference we calculated the slope of the regression of Ohba's measures on our measures for the eleven shared taxa. The regression had an intercept of zero, a slope of 0.42, and explained over 82% of the variance, indicating that our measures of antenna sizes were 0.42 as large as Ohba's (Figure S4). We thus multiplied all of Ohba's antenna size measures by 0.42 to combine the two data sets. Performing this correction made the measurement differences for the eleven overlapping species non-significant (Wilcoxon Signed-Rank Test, p=0.859). We used this correction for all antenna measurements in Ohba's data set and used these values for subsequent analyses of the combined data set.

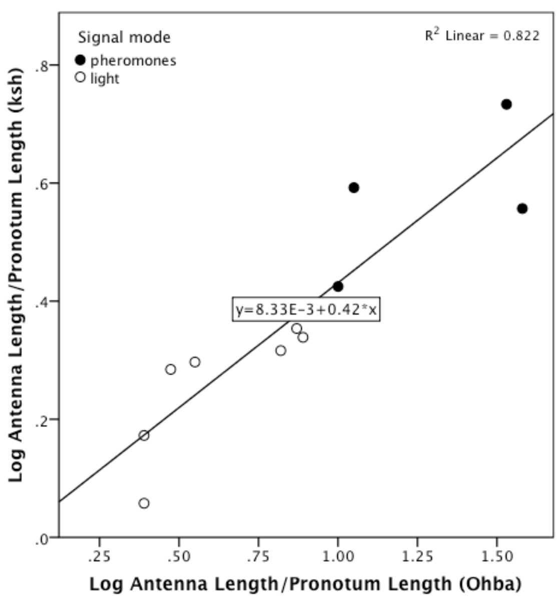


Fig. S4. KSH and Ohba antenna data sets: log-log graph of antenna data with fitted regression line: log a/p (ksh)= 8.33E-3+0.42*log a/p (Ohba).

4.2 Multivariate Analysis of eye and antenna size in 32 genera of the worldwide data set

We used scaled eye width and antenna length as dependent variables in a multivariate analysis of male sensor size for 101 firefly taxa in 32 genera.

Table S9: Worldwide Genera and species (N) used for a Multivariate analysis of male eye and antenna size. *Revised genus names (since Ohba 1978): see Table S4.

		Frequency	Percent
Valid	Aquatica****	1	1.0
	Bicellonycha	1	1.0
	Brachylampis	2	2.0
	Curtos	1	1.0
	Cyphonocerus	2	2.0
	Diaphanes	1	1.0
	Drilaster	1	1.0
	Ellychnia	5	5.0
	Lamprohiza	1	1.0
	Lampyris	2	2.0
	Lucidina	4	4.0
	Lucidota	2	2.0
	Luciola	5	5.0
	Lychnuris	1	1.0
	Medeopteryx**	1	1.0
	Micronaspis	2	2.0
	Microphotus	1	1.0
	Paraphausis	1	1.0
	Phausis	2	2.0
	Phosphaenus	1	1.0
	Photinus	34	33.7
	Photuris	8	7.9
	Pleotomus	2	2.0
	Pollaclassis	2	2.0
	Pristolycus	2	2.0
	Pteroptyx	1	1.0
	Pygatyphella***	1	1.0
	Pyractomena	5	5.0
	Pyractonema	1	1.0
	Pyrocoelia*	4	4.0
	Pyropyga	3	3.0
	Vesta	1	1.0
	Total	101	100.0

Box's Test of Equality of Covariance Matrices[a]

Box's M	59.003
F	2.111
df1	21
df2	926.710
Sig.	.003

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
LogEWPL	1.454	34	65	.097
LogALPLsc	1.578	34	65	.057

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + PFGW + genuscode

When testing for the homogeneity of covariance matrices (an assumption for multivariate tests), the Box test indicated that the covariances were not equal. Since the Box test is sensitive to small departures from normality in large data files, we also checked the diagonals of the covariance matrices using the Levene's test of equality of error variances, which were not significantly different.

Table S10: Multivariate analysis of eye and antenna size in the worldwide data set. PFGW= Pheromones/Flashes/Glows/Weak glows. LogEWPL= Log eye width/pronotum length, LogALPLsc= scaled Log antenna length/pronotum length. The interaction between genus and signal type was not significant and was therefore removed from the analysis.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	LogEWPL	3.600[a]	34	.106	21.186	.000	.917	720.308	1.000
	LogALPLsc	1.794[b]	34	.053	5.970	.000	.757	202.981	1.000
Intercept	LogEWPL	2.249	1	2.249	449.883	.000	.874	449.883	1.000
	LogALPLsc	.808	1	.808	91.434	.000	.584	91.434	1.000
PFGW	LogEWPL	.184	3	.061	12.243	.000	.361	36.729	1.000
	LogALPLsc	.086	3	.029	3.227	.028	.130	9.681	.717
genuscode	LogEWPL	1.732	31	.056	11.181	.000	.842	346.616	1.000
	LogALPLsc	.910	31	.029	3.322	.000	.613	102.996	1.000
Error	LogEWPL	.325	65	.005					
	LogALPLsc	.575	65	.009					
Total	LogEWPL	26.536	100						
	LogALPLsc	15.981	100						
Corrected Total	LogEWPL	3.925	99						
	LogALPLsc	2.369	99						

a. R Squared = .917 (Adjusted R Squared = .874)

b. R Squared = .757 (Adjusted R Squared = .631)

c. Computed using alpha = .05

4.3 Sexual Dimorphism: Visual representation of male and female data in Table S5

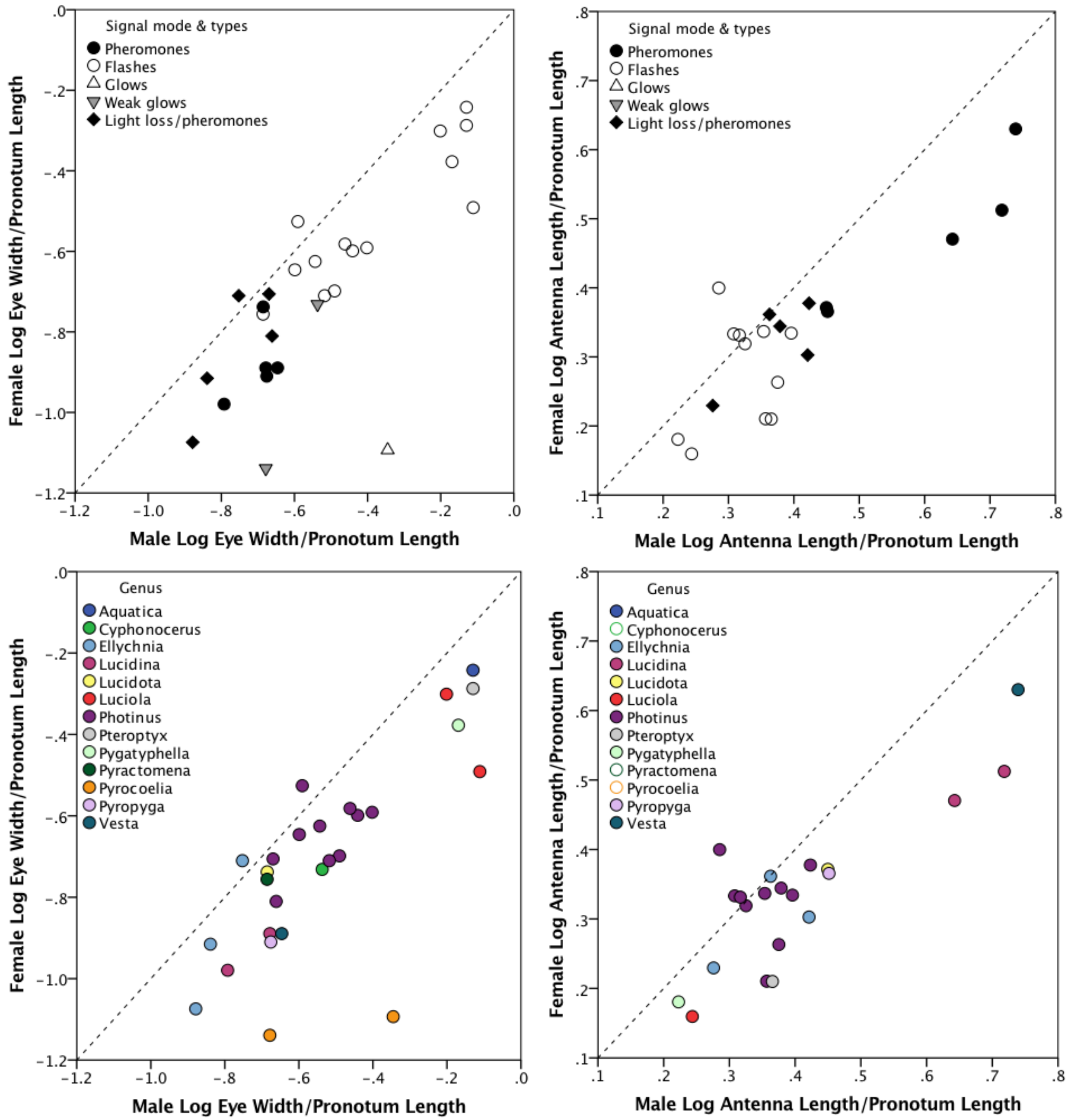


Fig. S5: **Worldwide data set for species with male and female measurements** for eye width (A: by signal mode & C: by genus, N=12) and antenna length (B: by signal mode & D: by genus, N=9). Note: no female antenna data for glowing and weakly glowing species (B), and represented by empty circles in genus legend (D). The diagonal lines represent equal (1:1) sensor sizes (scaled by body size) of males (M) and females (F). Above line: F>M and below: M>F. For individual species and measurements in different signal categories or genera see Table S5.

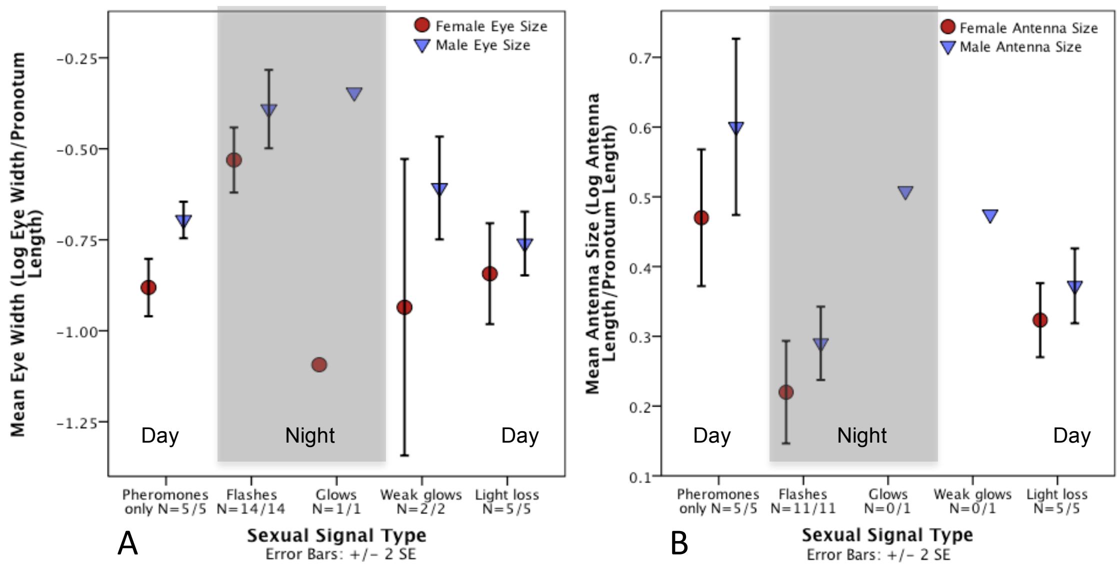


Fig. S6: Female and Male sensor traits by specific signal types (pheromones, flashes, glows, weak glows and recent reversals to pheromones) in the worldwide data set. A: Eye size (N=27 taxa) and B: Antenna size (N=21 taxa with both male and female data). N= N female/ N male. Shown are mean +/- 2SE (standard error). Weak glows (used during daylight in *Cyphonocerus* and some *Pyrocoelia* species: see Table S5) likely no longer function as sexual signals and pheromones are used instead.

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