Ecography

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Supplementary material

Appendix 1

Sources of seed rain data, site descriptions and values of net primary productivity (NPP, grams of carbon fixed per square metre per year, after losses to respiration) as estimated by BIOME4. Seed rain values are number of seeds falling per square metre of ground, per year. Altitude is in metres. If studies spanned a range of altitudes, we calculated a mean across the sites/range given.

Site	Vegetation	Latitude	Longitude	Seed rain	NPP	Altitude	Reference
Dja Reserve, Cameroon	semi-deciduous tropical rainforest	3°11′N	12°48′E	381	1575	Not reported	Clark et al. 2001
Southern Costa Rica	primary rain forest	08°57′N	82°50′W	1670		1500	Holl 1999
Barro Colorado Island, Panama	tropical moist forest	09°10′N	79°51′W	6488	2146	150	Augspurger and Franson 1988, Harms et al. 2000
Cairns, Australia	tropical moist forest	16°54′S	145°45′E	524	908	54	W. Edwards unpubl. data from 4 yr
Los Tuxtlas, Mexico	tropical rainforest	18°24′N	95°04′W	781	1098	Not reported	Martinez-Ramos and Soto-Casttro 1993
Thailand	tropical rainforest	18°47′N	98°59′E	811	1073	1350	Nicholas et al. 1992
Hainan Island, China	old-growth tropical montane rainforest	18°55′N	109°25′E	345		1050	Zong et al. 2007
Hawaii, USA	montane vegetation	19°20′N	155°9′W	5713		700	Drake 1998
Barão Geraldo, Brazil	semi-deciduous forest	22°49′S	47°06′W	442	1809	600	Grombone-Guaratini and Rodrigues 2002
Guizhou, China	mixed gymnosperm/ deciduous forest	25°05′N	107°59′E	910	1098	730	Liu 2000
Monte desert, Argentina	open woodlands, monte desert	34°02′S	67°58′W	3391	530	Not reported	Marone et al. 1998
Southern Appalachians, USA	deciduous forest	35°03′N	83°27′W	3873	1331	1133.5	Beckage et al. 2000
Tajimagahara, Japan	primrose community on floodplain	35°52′N	139°40′E	2084	1144	5.8	Masuda and Washitani 1990
Almería, Spain	mediterranean grassland/shrubland	37°08′N	2°22′W	6789	561	630	Willott et al. 2000
Beartooth Plateau, Montana, USA	alpine herbfield	38°30′N	109°30′W	5205	452	3200	Chambers 1993
Tucker Prairie, Missouri, USA	prairie grassland	38°50′N	92°50′W	19726	1228	Not reported	Rabinowitz and Rapp 1980
Kansas, USA	tallgrass prairie	39°03′N	95°12′W	55233	1262	Not reported	Schott and Hamburg 1997
California, USA	meadow	39°45′N	123°37′W	56868	300	Not reported	Kotanen 1996
New Jersey, USA	tidal marshes	40°13′N	74°46′W	3714	1105	0.5	Leck and Simpson 1994

Arapaho Prairie, Nebraska, USA	prairie grassland	42°N	102°W	2956	644	Not reported	Potvin 1988
Utah, USA	Pinyon-juniper woodlands	42°32′N	108°11′W	582	283	2300	Everett 1986
Craigieburn Range, New Zealand	grassland, herbfield, snowbank and fellfield	43°08′S	171°41′E	1921	41	1600	Spence 1990
Niagra escarpment, Ontario, Canada	cliff community	43°29′N	79°56′W	6508	949	Not reported	Booth and Larson 1998
Jakobshorn Mountain, Swiss alps	alpine grassland	46°46′N	9°51′E	930	215	2450	Urbanska et al. 1998
Upper Rhine, France	hardwood floodplain forest	48°20′N	7°38′E	1095	931	145	Deiller et al. 2003
Ontario, Canada	boreal mixedwood forest	49°11′N	88°42′W	1624	570	Not reported	Qi and Scarratt 1998
Rouen, France	chalk grassland	49°29′N	0°56′E	8079		45	Chabrerie and Alard 2005
Tierra del Fuego, Chile	*Nothofagus* forest	54°13′S	68°42′W	1081	274	850	Cuevas 2000
Southeastern central Sweden	wet meadows	60°16′N	16°50′E	7441	495	Not reported	Skoglund 1990
Northern boreal zone, Sweden	boreal forest	64°40′N	15°50′E	690	244	560	Hofgaard 1993
Abisko, Sweden	low arctic heath	68°21′N	18°29′E	513	44	1025	Molau and Larsson 2000, Larsson and Molau 2001
Kilpisjärvi, Finland	arctic meadows	69°01′N	20°50′E	975	126	680	Welling and Laine 2002
Kilpisjärvi, Finland	arctic heath	69°01′N	20°50′E	332	126	680	Welling and Laine 2002

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Appendix 2

Very small-seeded species (such as those produced by orchids, *Marcgravia, Cecropia* and *Miconia*) might be under-sampled in seed rain studies that use open mesh to trap seeds. Further, such methods might be favoured in the tropics, where the mean seed mass is larger. What would it mean for our data if there were a bias in seed rain sampling such that small-seeded species from the tropics were under-sampled?

Estimates of seed rain density

Because the total number of seeds a plant species can make each year from a given amount of canopy area is inversely proportional to seed mass (Aarssen and Jordan 2001, Henery and Westoby 2001), under-sampling the small-seeded species in a community would result in severe underestimates of total seed rain density. Thus, if tropical studies were under-sampling small-seeded species, they would be underestimating the total seed rain density, and the true slope of the relationship between seed rain density and latitude would be less (more negative, and thus more divergent from our hypothesis) than that shown in Fig. 1A.

Estimates of the total mass of seed falling

If small-seeded species in tropical ecosystems were also under-represented in Moles et al.'s study of the relationship between seed mass and latitude (Moles et al. 2007), then the mean seed mass in tropical ecosystems might have been overestimated. How much might this affect our estimates of the total mass of seed produced?

Because seed mass is inversely proportional to the number of seeds produced per square metre of canopy area, and because there is no consistent relationship between seed mass and species' abundance (Leishman and Murray 2001), multiplying mean seed mass by mean seed rain density is expected to produce reasonable estimates of the total mass of seed falling in an ecosystem. That is, small-seeded species are expected to produce a similar total mass of seed to large-seeded species, albeit in more, smaller packages. Thus, adding a small-seeded species to a community would increase the total density of seed rain, as well as decreasing the mean seed mass, and the net effect would be to increase the total mass of seed falling by the amount of seed produced by one species. Therefore, if small-seeded species were under-sampled in tropical seed rain studies to the same extent that they are under-sampled in the seed mass study, the effect would be to underestimate the total mass of seed falling in tropical ecosystems. If small-seeded species were under-sampled in tropical seed rain studies more than they are under-sampled in the seed mass study, the effect would be an even more severe underestimate the total mass of seed falling in tropical ecosystems. The only way that a sampling bias against small-seeded species in the tropics could lead to overestimates of the mass of seed falling in tropical ecosystems would be if small-seeded species were much more strongly under-sampled in studies of seed mass than in studies of seed rain. While this is not impossible, it does seem that studies of species' seed mass (in which seed is often collected directly from fruits or branches) are less likely to selectively exclude small-seeded species than are studies of seed rain (in which raised, open mesh traps are often used to avoid problems with rainfall and seed predation).

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