Appendix I.

Literature sources for pollen: ovule ratios of Apocynaceae.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Lineage (subfamily or tribe)** | **Species** | **Pollen aggregation** | **Pollen: ovule ratio per flower** | **Primary reference** | **Secondary reference** |
| Asclepiadoideae | *Asclepias* *amplexicaulis* Michx. | pollinia | 10.9 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *arenaria* Torr. | pollinia | 7.6 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *asperula* (Decne.) Woodson | pollinia | 8.7 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *brachystephana* Engelm. ex Torr. | pollinia | 7.3 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *cinerea* Walter | pollinia | 20.9 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *curassavica* F.C.Ho | pollinia | 6.9 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *exaltata* L. | pollinia | 18 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *fruticosa* L. | pollinia | 5.3 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *incarnata* B.Boivin | pollinia | 8.5 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *lanceolata* Fernald | pollinia | 15.3 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *latifolia* Britton | pollinia | 7.7 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *longifolia* Michx. | pollinia | 10 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *obovata* Elliott | pollinia | 91 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *oenotheroides* Cham. & Schltdl. | pollinia | 7.5 | Cruden 1977 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *oenotheroides* Cham. & Schltdl. | pollinia | 9.4 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *perennis* A.Gray | pollinia | 7.8 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *purpurascens* L. | pollinia | 7.3 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *speciosa* Torr. | pollinia | 10.0 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *subulata* Larrañaga | pollinia | 6.6 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *subverticillata* Vail | pollinia | 10.8 | Cruden 1977 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *syriaca* L. | pollinia | 10.9 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *texana* Heller | pollinia | 9.2 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *tuberosa* Woodson | pollinia | 6.2 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *variegata* Hook. | pollinia | 8.6 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *verticillata* A.Gray | pollinia | 6.6 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *verticillata* A.Gray | pollinia | 10.1 | Cruden 1977 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *viridiflora* Hook. | pollinia | 10.5 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Asclepias* *viridis* Walter | pollinia | 6.3 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Calotropis* *procera* (Aiton) W.T.Aiton | pollinia | 6.1 | Ali & Ali 1989 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Calotropis* *procera* (Aiton) W.T.Aiton | pollinia | 10.4 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Ceropegia* *woodii* Schltr. | pollinia | 8.3 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Cynanchum* *grandiflorum* Cav. | pollinia | 16.9 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Cynanchum* *wilfordii* (Maxim.) Maxim. ex Hook. f. | pollinia | 21.9 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Funastrum* *clausum* (Jacq.) Schltr. | pollinia | 7.4 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Funastrum* *cynanchoides* (Decne.) Schltr. | pollinia | 7.8 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Hoya* *carnosa* (L. f.) R. Br. | pollinia | 5.8 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Huernia* *sp.* | pollinia | 2.7 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Matelea* *carolinensis* (Jacq.) Woodson | pollinia | 12.6 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Matelea* *chrysantha* (Greenm.) Woodson | pollinia | 4.9 | Cruden 1977 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Matelea* *decipiens* (Alexander) Woodson | pollinia | 8.2 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Matelea* *pavonii* (Decne.) Woodson | pollinia | 3.8 | Cruden 1977 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Matelea* *pilosa* (Benth.) Woodson | pollinia | 5.7 | Cruden 1977 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Metaplexis* *japonica* Makino | pollinia | 21.0 | Tanaka et al. 2006 |  |
| Asclepiadoideae | *Oxypetalum* *coeruleum* (D. Don ex Sweet) Decne. | pollinia | 10.1 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Pergularia* *daemia* (E.Mey.) Goyder | pollinia | 17.8 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Asclepiadoideae | *Vincetoxicum* *officinale* Moench | pollinia | 6.0 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Aspidospermeae | *Aspidosperma* *quebracho-blanco* Schltdl. | monads | 52 | Lin & Bernardello 1999 |  |
| Mesechiteae | *Mandevilla* *pentlandiana* (A.DC.) Woodson | monads | 45 | Torres & Galetto 1999 | Erbar & Langlotz 2005 |
| Mesechiteae | *Mandevilla* *sp.* | monads | 61 | Lohne et al. 2004 | Erbar & Langlotz 2005 |
| Nerieae | *Nerium* *oleander* L. | monads | 31 | Herrera 1991 |  |
| Periplocoideae | *Decalepis* *hamiltonii* Wight & Arn. | pollinia | 20 | Raju & Ramana 2009 |  |
| Periplocoideae | *Periploca* *aphylla* Decne. | tetrads | 315 | Wyatt et al. 2000 | Erbar & Langlotz 2005 |
| Plumerieae | *Allamanda blanchetii* A. DC. | monads | 168 | Araujo et al. 2011 |  |
| Tabernaemontaneae | *Tabernaemontana* *undulata* Vahl | monads | 51 | de Moura et al. 2011 |  |
| Vinceae | *Vinca* *minor* H.Scholz | monads | 204 | Christ et al. 2001 | Erbar & Langlotz 2005 |
| Willughbeieae | *Hancornia* *speciosa* Gomes | monads | 77 | Darrault & Schlindwein 2005 |  |
| Wrightieae | *Wrightia* *tinctoria* R.Br. | monads | 44 | Raju et al. 2005 |  |

Appendix II.

Literature sources for pollen transfer efficiencies (PTE) in Figure 4.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Lineage (family, subfamily, or tribe)** | **Species** | **Pollen aggregation** | **Pollen transfer efficiency (%)** | **Primary reference** | **Secondary reference** | **Note** |
| Alstroemeriaceae | *Alstroemeria* *aurea* Graham | monads | 0.1 | Aizen and Raffaele 1996 | Harder & Johnson 2008 | average # pollen grains removed per anther *=* 16560; 6 anthers per flower; average # pollen grains deposited per stigma *=* 97.9 |
| Anacardiaceae | *Anacardium* *occidentale* L. | monads | 1.0 | Freitas and Paxton 1998 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Asclepias* *cucullata* Schltr. | pollinia | 5.0 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Asclepias* *exaltata* L. | pollinia | 25.5 | Broyles & Wyatt 1995 | Harder & Johnson 2008 | average of 1990 (23%) and 1991 (28%) |
| Apocynaceae, Asclepiadoideae | *Asclepias* *fruticosa* L. | pollinia | 15.2 | Harder & Johnson 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Asclepias* *tuberosa* Woodson | pollinia | 22.2 | Wyatt 1976 | Harder & Johnson 2008 | PTE calculated from linear regression equation of Fig. 6 |
| Apocynaceae, Asclepiadoideae | *Asclepias* *woodii* Schltr. | pollinia | 1.0 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Aspidonepsis* *diploglossa* (Turcz.) Nicholas & Goyder | pollinia | 6.0 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Cynanchum* *harlingii* Morillo | pollinia | 73.7 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Ditassa* *anderssonii* Morillo | pollinia | 28.6 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Ditassa* *endoleuca* Schltr. | pollinia | 21.1 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Funastrum* *clausum* (Jacq.) Schltr. | pollinia | 81.8 | Kunze & Liede 1991 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Funastrum* *pannosum* Schltr. | pollinia | 42.4 | Kunze & Liede 1991 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Gonolobus* *suberosus* (L.) R. Br. | pollinia | 13.3 | Lipow & Wyatt 1998 | Harder & Johnson 2008 | estimate based on number of flowers with removed and deposited pollinia |
| Apocynaceae, Asclepiadoideae | *Jobinia* *chlorantha* (K. Schum.) Malme | pollinia | 28.6 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Metaplexis* *japonica* Makino | pollinia | 19.2 | Tanaka et al. 2006 | Harder & Johnson 2008 | 10 pollinia deposited divided by 52 removed |
| Apocynaceae, Asclepiadoideae | *Microloma* *sagittatum* Wanntorp | pollinia | 33.1 | Pauw 1998 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Miraglossum* *pilosum* (Schltr.) Kupicha | pollinia | 17 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Miraglossum* *verticillare* (Schltr.) Kupicha | pollinia | 80 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Orthosia* *ellemannii* (Morillo) Liede & Meve | pollinia | 13.3 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *alpinum* (Vell.) Fontella & E.A. Schwarz | pollinia | 19.6 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *appendiculatum* Mart. | pollinia | 21.8 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *banskii* Schult. | pollinia | 1.3 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *jacobinae* Decne. | pollinia | 25.2 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *mexiae* Malme | pollinia | 7.0 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *pachyglossum* Decne. | pollinia | 18.2 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *sp.* | pollinia | 48.7 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Oxypetalum* *subriparium* Malme | pollinia | 0.41 | Vieira & Sherpard 2002 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Pachycarpus* *appendiculatus* E.Mey. | pollinia | 35.3 | Shuttleworth & Johnson 2009 |  | Average of PTE in field (28.1%) and cage (42.5%) experiments |
| Apocynaceae, Asclepiadoideae | *Pachycarpus* *asperifolius* Meisn. | pollinia | 20.9 | Shuttleworth & Johnson 2006 |  | Average of 3 populations: 42.7%, 19.0%, 15.0% PTE |
| Apocynaceae, Asclepiadoideae | *Pachycarpus* *natalensis* N.E.Br. | pollinia | 6.0 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Scyphostelma* *sp. A* | pollinia | 75.5 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Scyphostelma* *sp. B* | pollinia | 54.5 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Scyphostelma* *sp. C* | pollinia | 38.9 | Wolff et al. 2008 |  |  |
| Apocynaceae, Asclepiadoideae | *Sisyranthus* *trichostomus* K.Schum. | pollinia | 20 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Xysmalobium* *gerrardii* Scott-Elliot | pollinia | 10 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Xysmalobium* *involucratum* Decne. | pollinia | 0 | Ollerton et al. 2003 | Harder & Johnson 2008 |  |
| Apocynaceae, Asclepiadoideae | *Xysmalobium* *undulatum* (L.) Ait. | pollinia | 14.9 | Shuttleworth & Johnson 2008 |  | 3 populations with PTEs of 1.9%, 16.4%, and 13.4%. Population with low PTE had low presence of more effective pollinator (wasps). Species PTE *=* average of 2 populations with wasps present. |
| Balsaminaceae | *Impatiens* *capensis* Meerb. | monads | 0.64 | Young et al. 2007 |  | PTE from visits by nectar collecting *Apis mellifera*. Nectar collecting *Bombus* PTE *=* 0.28% |
| Bignoniaceae | *Campsis* *grandiflora* (Thunb.) K. Schum. | monads | 3.4 | Ren et al. 2010 |  | PTE for vespid wasps.  PTE for halictid bees *=* 2.2%.  Calculated for single visit experiments, average pollen deposition divided by average pollen removal. |
| Brassicaceae | *Raphanus* *raphanistrum* L. | monads | 0.1 | Conner et al. 1995 |  | *Apis mellifera* |
| Brassicaceae | *Raphanus* *sativus* L. | monads | 0.63 | Young and Stanton 1990 | Harder & Johnson 2008 | *Apis mellifera*.  Calculated for single visit experiments, average pollen deposition divided by average pollen removal. |
| Droseraceae | *Drosera* *tracyi* (Macfarl. ex Diels) Macfarl. | tetrads | 13 | Wilson 1995 | Harder & Johnson 2008 | Total pollen content per flower *=* 4254 ± 981.0 tetrads.  "Nearly 100% of the pollen in anthers is removed by bees in a few visits, and often after just one visit stigmas saturate at about 2.75 log unit grains." p. 387  2.75 *=* log (pollen deposited +1) *=* 561 tetrads. PTE *=* 561/4254 *=* 13% |
| Fabaceae | *Cassia* *reticulata* Willd | monads | 0.1 | Snow & Roubik 1987 | Harder & Johnson 2008 |  |
| Liliaceae | *Erythronium* *grandiflorum* Pursh | monads | 0.6 | Harder & Thomson 1989 | Harder & Johnson 2008 |  |
| Malvaceae | *Malvaviscus* *arboreus* Cav. | monads | 3.1 | Webb & Bawa 1983 | Harder & Johnson 2008 | PTE from small and large plants averaged (Tab. 1). |
| Orobanchaceae | *Melampyrum* *roseum* Maxim. | monads | 0.07 | Hiei & Suzuki 2001 | Harder & Johnson 2008 | *Bombus honshuensis*; pollen deposition per visit *=* 63 grains; pollen removal per visit *=* 96,000 grains. |
| Plantaginaceae | *Penstemon* *barbatus* (Cav.) Roth | monads | 2.5 | Castellanos et al. 2003 |  | hummingbird pollinated |
| Plantaginaceae | *Penstemon* *strictus* Benth. | monads | 1.6 | Castellanos et al. 2003 |  | both bee and hummingbird pollination |
| Polemoniaceae | *Polemonium* *viscosum* Nutt. | monads | 2.9 | Galen & Stanton 1989 | Harder & Johnson 2008 | Nectar collecting bumblebees |
| Ranunculaceae | *Aconitum* *septentrionale* Koelle | monads | 1.6 | Thostesen & Olesen 1996 |  | bumblebee pollination |