NOTES ON POLLINATION ECOLOGY OF *ALTENSTEINIA FIMBRIATA* KUNTH IN THE CITY OF QUITO, ECUADOR

Martín Carrera*,[1,2] **& Luis Baquero**[3]

[1]*Wildlife Conservation Society – Ecuador Program, Quito, Ecuador*
[2]*Grupo de Investigación Dodson, Calle A #100 y Edmundo Carvajal, Quito 170510, Pichincha, Ecuador*
[3]*Grupo de Investigación en Biodiversidad, Medio Ambiente y Salud (BIOMAS), Carrera de Ingeniería en Agroindustria, Facultad de Ingenierías y Ciencias Aplicadas,Universidad de Las Américas, UDLA, Vía a Nayón, Quito 170124, Ecuador*

Journal of Pollination Ecology, 37(21), 2024, pp 341-349

DOI: 10.26786/1920-7603(2024)786

Received 28 January 2024, accepted 3 December 2024

*Corresponding author: martin-cl@hotmail.com

Abstract—Most orchid species face significant challenges in urban environments. Particularly, pollination services and reproductive success can be altered due to habitat fragmentation related to human activities. Despite this, several terrestrial orchid species thrive in these environments. This study investigates the pollination ecology of *Altensteinia fimbriata*, a terrestrial orchid prevalent in disturbed habitats from the neotropics. This research aims to identify the pollination mechanism and to list the pollinators and floral visitors associated to *A. fimbriata*. During 30 hours of observation in a patch with 60 inflorescences of *A. fimbriata* within an anthropic area of the city of Quito, Ecuador, we recorded 121 visits from ten moth species, identifying four moth species as effective pollinators. Three of the pollinator species were noctuid moths. Moth activity peaked in the evening, coinciding with the emission of distinctive floral scents, suggesting that both scent and nectar attract visitors. We found that the four pollinators of *A. fimbriata* transfer polliniariums using their legs. This pollination mechanism is found in other terrestrial orchid species from different subtribes where noctuid moths are also the main pollinators. Our findings highlight the adaptability of *A. fimbriata* in urbanized areas and emphasize the need to understand its pollination dynamics in the context of global change.

Keywords—Urban orchid, Noctuidae, moth pollination, terrestrial orchids, Cranichidinae.

INTRODUCTION

The Orchidaceae family is one of the most diverse families of flowering plants globally, comprising approximately 28,000 species found on every continent except Antarctica (Dressler 2005; Salazar 2005; Christenhusz & Byng 2016; Goswami et al. 2024). Urban areas significantly influence pollinator communities of terrestrial orchids, impacting their reproductive success (Swarts & Dixon 2009; Newman et al. 2013). Habitat fragmentation isolates orchid populations, limiting access to pollinators and reducing visitation rates (Murren 2002; Meekers & Honnay 2011). For example, small anthropized populations of *Serapias cordigera* L (Orchidaceae) have lower population viability and low reproductive success than bigger, natural populations due to the lack of pollinators (Pellegrino & Bellusci 2014). However, some species can benefit from fragmented urban environments as demonstrated by Rewicz et al. (2017), where 70 species of terrestrial orchids from Europe thrive in highly anthropized habitats such as cities. Anthropic areas should be taken into consideration when developing conservation strategies of terrestrial orchid populations in scenarios of global change (Rewicz et al. 2017; Phillips et al. 2020; Wraith et al. 2020; Ackerman 2021).

Altensteinia fimbriata Kunth (Orchidaceae) is a common and robust terrestrial orchid that occurs from west South America to northwest Venezuela in the montane tropical biome. This species inhabits various habitats such as xerophilic grounds or grasslands at elevations between 1,800 to 3,300 m a.s.l. (Trujillo 2013; Tropicos 2023), but as in other terrestrial orchid species, *A. fimbriata* also inhabits disturbed areas, such as forests with degraded soil and invasive species (Seaton et al. 2010; Trujillo 2013; Rewicz et al. 2017). *A. fimbriata* is recognized by its terrestrial, rosette-shaped habit and a robust inflorescence that can grow up to 40 cm. The flowers are greenish with dry sepals, obtuse petals with ciliate margins, pubescent floral bracts, and the presence of nectar (Dodson & Escobar-Restrepo 1993; Salazar 2009; Borba et al. 2014; Nowak et al. 2014) (please refer to Fig. 1 for a detailed description of *A. fimbriata* flowers). Additionally, *A. fimbriata* emits an unpleasant floral scent during the evening, around 20:00 h approximately (G. Salazar, personal communication). These characteristics suggests that *A. fimbriata* may be pollinated by nocturnal moths, yet to our knowledge nothing is known about the pollination ecology of this species.

The main objective of our research is to describe the pollination mechanism of *A. fimbriata,* and to report the pollinators, floral visitors, and fauna associated to *A. fimbriata* plants inhabiting an anthropized area. Ackerman et al. (2023) suggested that species that reward with nectar to the pollinators, like *Rodriguezia granadensis* (Lindl.) Rchb.f. (Orchidaceae), have less pollinator species and no specific pollination mechanism. Given that *A. fimbriata* has nectar and a green-white coloration in the flowers, we expect several species of moths as potential pollinators (Yurtsever et al. 2010). Documenting the pollination ecology of a common species such as *A. fimbriata* in environments influenced by urbanization is crucial for understanding the adaptive mechanisms of resilient orchids to global change (Trujillo 2013; Reina-Rodríguez et al. 2017; Wraith et al. 2020; Ackerman 2021).

MATERIALS AND METHODS

STUDY SITE

Our research was conducted in Parque Metropolitano Guanguiltagua, located in Quito at an elevation of 2,800 meters above sea level, covering approximately 600 hectares. The park has experienced historical modifications, leading to eroded soil, negative effects of invasive species, and native species primarily isolated in creeks(EPMAPS 2011). Our study site is situated in the northern section of the park, near "Comuna

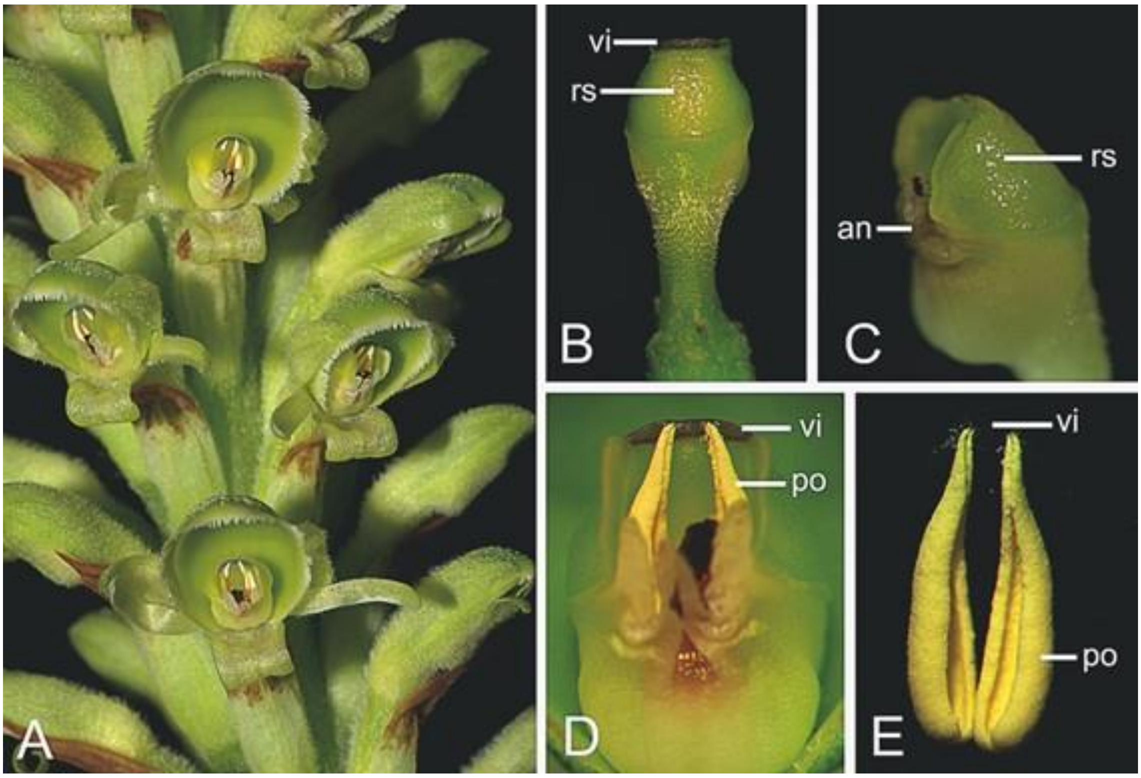

Figure 1: Floral morphology of *Altensteinia fimbriata*. A. Part of the inflorescence; B. Column from below; C. Column apex, from side; D. Column apex, from above; E. Pollinarium. Abbreviations: an = anther; rs = receptive stigmatic area; vi = viscidium (Originally published by Salazar (2009), reproduced with the authorization of the author).

Miraflores" (latitude: -0.165866º, longitude: -78.465099º). In this area, clusters of *Altensteinia fimbriata* commonly grow with grasses such as *Pennisetum clandestinum* Hochst. ex Chiov and invasive trees like *Eucalyptus globulus* Labill and *E. longifolia* Link, which dominate the park landscape and pose significant invasive threats.

FIELD CAMPAIGNS

During the flowering season of *A. fimbriata*, from May 31st to June 9th, 2022, we conducted random walks in our study area, focusing on a patch containing 55 individuals of *A. fimbriata*, with a total of 60 inflorescences, each holding approximately 65 flowers. Observations were conducted between 18:00 h and 21:00 h, totalling 30 hours of active observation by a single observer. However, we also visited the *A. fimbriata* patch several times throughout the day and night to perform additional observations for potential diurnal pollinators. Using a smartphone camera equipped with a macro lens, we recorded all animal visitations to the inflorescences, every visitor was carefully observed and photographed. Tracking was not possible because of the flying speed of the individuals and due to the high abundance of visitors, having several visitors in the same plant individual. Additionally, due to the abundance of visitors, quantifying each species abundance was challenging without the risk of double counting. Nonetheless, we recorded the number of visits for each species. To avoid disturbance in the pollination events, no specimens of pollinators were collected during the study.

We categorized species visiting *A. fimbriata* flowers as visitors if they were observed moving within or remaining in the flowers without carrying any pollinariums. Pollinators were defined as species interacting with *A. fimbriata* that carried pollinariums. Identification of pollinators and visitors was conducted using original species descriptions or identification guides specific to each species.

RESULTS

Moth activity around the inflorescences of *A. fimbriata* peaked between 18:30 and 20:00, followed by a clear decline after 20:00. This peak coincided with the existence of a distinctive, unpleasant floral scent. We identified ten moth species interacting with the inflorescences of *A. fimbriata* (Tab. 1, Fig. 2 A-J). Among these moth species, the family Noctuidae had the highest diversity, with six species, followed by Geometridae with two species, and Crambidae and Erebidae each

Table 1. List of the species associated with *A. fimbriata* classified by their status as true pollinator and visitor, with notes about its distribution.

Status	Family	Species	Distribution	Number of visits	Reference
Pollinator	Geometridae	*Bassania olivacea*	Guatemala-Perú	10	Warren 1896
	Noctuidae	*Condica mobilis*	Americas	15	Becker & Miller 2002
		Mythimna unipuncta	Middle East, Europe, Americas	21	DGSV-DCNRF 2019
		Peridroma saucia	Europe-Americas	27	Fajardo & Serna 2006
Visitor	Crambidae	*Herpetogramma phaeopteralis*	Americas	12	Tofangsazi et al. 2014.
	Erebidae	*Tetanolita mynesalis*	Americas	19	Holland 1905
	Geometridae	*Psamatodes abydata*	Americas	11	Ferguson 2008
	Noctuidae	*Dargida procinctus*	Canada to Bolivia	4	Pogue 2009
		Feltia subterranea	Americas	1	Capinera 2013
		Megalographa biloba	Americas	1	Lafontaine & Sullivan 2009
	Anyphaenidae	*Hatitia* sp	----	8	Peñaherrera-R P. Pers. com., 2024
	Tetragnathidae	*Leucauge* sp	----	12	Peñaherrera-R P. Pers. com., 2024

Figure 2. Species pollinating or visiting *A. fimbriata*. Pollinators: (A) *Bassania olivacea.* (B) *Condica mobilis.* (C) *Mythimna unipunctata.* (D) *Peridroma saucia.* Red arrows show pollinariums in the legs of the individuals. Visitors: (E) *Herpetogramma phaeopteralis.* (F) *Tetanolita mynesalis.* (G) *Psamatodes abydata.* (H) *Dargida procintus.* (I) *Feltia subterranea.* (J) *Megalographa biloba.* (K) Spider *Hatitia* sp. feeding on *Tetanolita mynesalis.* (L) Spider *Leucauge* sp.

represented by one species. We recorded a total of 121 visitations in 60 inflorescences in 30 hours of observation, resulting in a visitation rate of 0.067 visitors per inflorescence per hour. Four of the ten moth species were categorized as pollinators and accounted for 60.4 % of the recorded visits, while the remaining six visitor species accounted for 39.6 % of the visits (Fig. 3).

POLLINATOR SPECIES AND BEHAVIOUR

Four moth species, *Bassania olivacea* Warren (Geometridae), *Condica mobilis* Walker (Noctuidae), *Mythimna unipuncta* Haworth (Noctuidae), and *Peridroma saucia* Hübner (Noctuidae) were identified as pollinators, as they were observed carrying pollinariums on their legs. Notably, only *Bassania olivacea* was observed depositing the pollinarium onto the stigma of *A. fimbriata* using its legs. All the moth species were observed showing the same behavioural pattern: they flew towards the lower area of an inflorescence, then ascended towards the higher regions, utilizing both their legs and wings for climbing while simultaneously probing various parts of the flower with their proboscis. After reaching the apex of the inflorescence, moths would fly to another inflorescence and repeat the process. During their ascent, moths were primarily observed carrying pollinariums with their front pair of legs, occasionally with the middle and hind pairs as well. As they ascended, moths deposited the pollinariums onto the stigmatic area, as observed in *Bassania olivacea*, but also in other areas of the flower, like the dorsal sepal mainly.

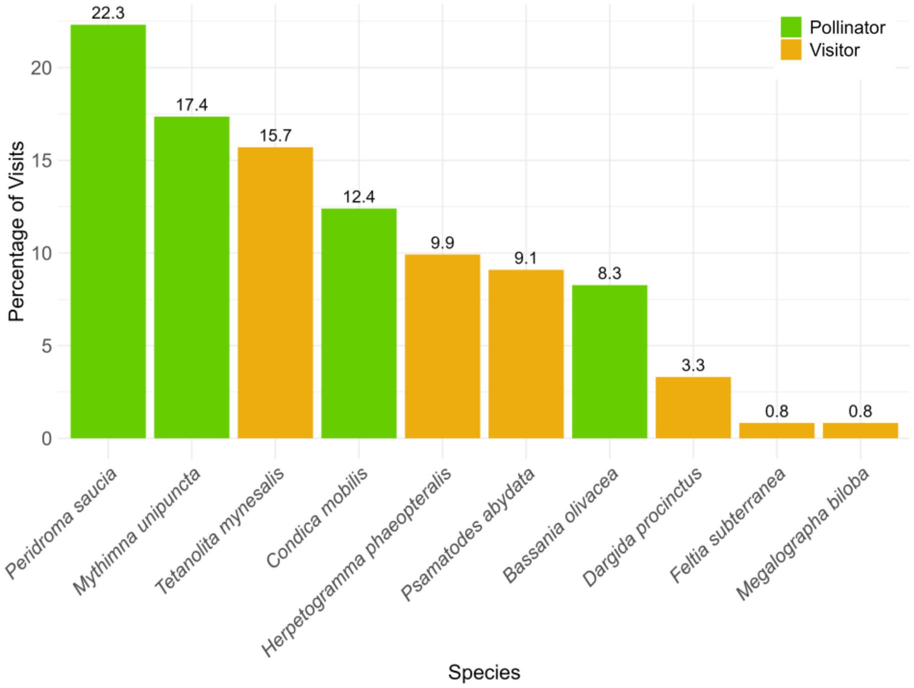

Figure 3. Rank-abundance plot depicting the percentage of plant visits performed by each moth species. Green bars correspond to pollinator species and orange bars correspond to visitor species.

Additionally, individuals were observed collecting pollinariums from one inflorescence and depositing the pollinariums in various parts of the flowers of a different inflorescence, suggesting cross-pollination events.

Interestingly, we encountered several flowers that had been recently and successfully pollinated by moths. These flowers exhibited a pollinarium in the stigmatic area, with dismembered moth legs attached to the viscidium of the pollinarium (Fig. 4). Furthermore, we observed an individual of *Bassania olivacea* carrying ten pairs of pollinarium on its legs. This moth was found incapacitated, unable to fly or walk properly, and was discovered on the ground near an *A. fimbriata* inflorescence, visibly struggling to move and displaying signs of weakness.

VISITOR SPECIES AND BEHAVIOUR

Six moth species, *Herpetogramma phaeopteralis* Guenée (Crambidae), *Tetanolita mynesalis* Walter (Erebidae), *Psamatodes abydata* Guenée (Geometridae), *Feltia subterranea* Fabricius (Noctuidae), *Megalographa biloba* Stephens (Noctuidae), and *Dargida procinctus* Grote (Noctuidae), were categorized as visitors rather than pollinators, as they interacted with the inflorescences but were not found carrying pollinariums. Visitor species exhibited a similar behaviour when compared to the pollinator species, but they were less active, and they were not found extracting pollinariums from the flowers. During our observations, we encountered two species of spiders: *Hatitia* sp. active during the night, and *Leucauge* sp. active during the day (Fig 2. K-L). Both spider species were observed in top of the inflorescences, where they constructed webs. Additionally, *Hatitia* sp. was observed feeding on a moth.

DISCUSSION

The notorious activity of pollinators near the inflorescences of *A. fimbriata* matches with the activation of strong floral scents, as noted by Gerlach & Schill (1991), Borba et al. (2014), and Salazar (2009), where various orchid species emit distinct scents at specific hours or flower stages to attract pollinators. Apart from scents to attract pollinators, *A. fimbriata* produces nectar. Ackerman et al. (2023) suggested that nectar-rewarding orchid species such as *Gomphichis valida* Rchb. f, a close species to *A. fimbriata* that attracts bumblebees, bees, and hummingbirds as pollinators, and species like *Rodriguezia granadensis* (Lindl.) Rchb.f. (Orchidaceae) or *Caladenia nobilis* Hopper & A.P.Br (Orchidaceae) have lower pollinator specificity and a broad range of non-pollinating visitors (Ackerman et al. 2023; Quispe

Figure 4. Dismembered leg of an unidentified moth individual attached to the pollinarium which is also attached to the stigmatic area of *Altensteinia fimbriata.*

& Singer 2024). In line with this, we found that only four of the ten observed moths acted as pollinators of *A. fimbriata*, suggesting a low specificity. However, further studies are needed to know if this same pattern applies to the case of *A. fimbriata.* And as additional information, from the four species of pollinators reported for *A. fimbriata* in this study, only *Mythimna unipunctata* has been reported as a pollinator of the terrestrial orchid *Platanthera dilatata* (Pursh) Lindl. Ex Beck (Orchidaceae), another nectar rewarding species from the Orchidinae subtribe, carrying pollinariums in the proboscis (Janes et al. 2024).

Our findings reveal four species of pollinators with broad distribution ranges, coincidentally the most frequently observed visitors to the inflorescences (Warren 1896; Becker & Miller 2002; Fajardo & Serna 2006; DGSV-DCNRF 2019). This data suggests that *A. fimbriata* may not be strictly specific to one pollinator species and may rely on the most abundant species of moths for pollination. Nevertheless, all four species, even from different families, showed the same behavioural pattern resulting in the same pollination mechanism, using the legs to carry the pollinariums. Interestingly, this same behaviour has been observed in other nectar-rewarding orchid species. For instance, Tao et al. (2018) documented that the moths *Cucullia fraterna* Butler (Noctuidae) and *Trichoplusia intermixta* Warren (Noctuidae), which pollinate *Habenaria limprichtii* Schltr (Orchidaceae), carry pollinariums on their legs during the pollination process. Similarly, *Habenaria epipactidea* Rchb.f (Orchidaceae) is pollinated by the moth *Hippotion celerio* Linnaeus (Noctuidae), with the moth species also transporting the pollinariums on their legs. Despite the taxonomic distinction between the genus *Habenaria* of the Habenariinae subtribe and *Altensteinia* of the Cranichidinae subtribe, the moth pollinators mainly belong to the Noctuidae family and carry the pollinariums on their legs, indicating specificity in the pollination mechanism. These examples suggest convergent evolution between orchids from different subtribes associated with noctuid moths.

An interesting observation arising from this study was the presence of dismembered moth legs in the inflorescences of *A. fimbriata* (Fig. 4). One possible explanation for this occurrence is predation events by spider species. Alternatively, it is possible that the viscidium of the pollinarium has a potent adhesive property capable of causing harm to moths. This harm may occur not only in leg dismemberment but also in constraints on moth movement, as exemplified by the case of one individual *Bassania olivacea* found struggling to move on the ground. Further observations are needed to investigate whether spider species indirectly influence pollination events and to evaluate the potential harm posed to moth individuals by the adhesive properties of the viscidium.

With this context, further observations inside the extensive distribution range of *A. fimbriata* are necessary to confirm if *A. fimbriata* can self-pollinate in the absence of pollinators. Additionally, the apparently specific pollination mechanism must be tested in pristine areas where *A. fimbriata* also occurs. Maybe in this area the pollination mechanism and pollinator assemblage is different when compared to anthropic areas. A broad understanding of the pollination ecology of *A. fimbriata* could be pertinent in scenarios where *A. fimbriata* faces future environmental change (Trujillo 2013; Reina-Rodríguez et al. 2017; Wraith et al. 2020; Ackerman 2021).

ACKNOWLEDGEMENTS

We express our gratitude to Gerardo Salazar (UNAM) for useful suggestions and allowing us to use a floral morphology figure of *Altensteinia fimbriata.* To Pedro Peñaherrera-R (ZSFQ) for his assistance in providing information regarding the spider species observed in our study. Additionally, we extend our thanks to Universidad de Las Américas (UDLA) for their generous funding support towards orchid research in Ecuador. We would also like to acknowledge the editors and reviewers for their diligent efforts during the revision process of this paper. Lastly, we affirm that this paper was developed without any conflicts of interest.

AUTHOR CONTRIBUTION

Concept and design DS & EC, data collection EC, data analysis DS, writing DS, edits and approval for publication DS & EC. To: Concept and design MC and LB, data collection MC, data analysis MC, writing MC and LB, edits and approval for publication MC and LB.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

DATA AVAILABILITY STATEMENT

The data used to write this article are available in this article. Please contact the corresponding author for data requests or further information.

REFERENCES

Ackerman J (2021) Orchids on the move: go forth & proliferate!. In: Wang Y-T, Chang Y-CA, Lee Y-I, Chen F-C, Tsai W-C (eds) Proceedings of the 2021 Virtual World Orchid Conference, Taiwan. Orchid Growers Association, Taiwan, pp 262-266.

Ackerman J, Phillips R, Tremblay R, Karremans A, Reiter N, Craig P, Bogarín D, Pérez-Escobar O, Liu H (2023) Beyond the various contrivances by which orchids are pollinated: global patterns in orchid pollination biology. Botanical Journal of the Linnean Society 202:295-324. https://doi.org/10.1093/botlinnean/boac082

Becker V, Miller S (2002) The large moths of Guana island, British Virgin Islands: A survey of efficient colonizers (Sphingidae, Notodontidae, Noctuidae, Arctiidae, Geometridae, Hyblaeidae, Cossidae). Journal of the Lepidopterist Society 56:9-44.

Borba E, Salazar GA, Mazzoni-Viveiros S, Batista J (2014) Phylogenetic position and floral morphology of the Brazilian endemic, monospecific genus *Cotylolabium*: a sister group for the remaining Spiranthinae (Orchidaceae). Botanical Journal of the Linnean Society 175:29-46. https://doi.org/10.1111/boj.12136

Capinera J (2013) Granulate Cutworm, *Feltia subterranea* (Fabricius) (Insecta: Lepidoptera: Noctuidae). UF/IFAS Extension 2013: 1-4. https://doi.org/10.32473/edis-in997-2013

Christenhusz MJM, Byng JW (2016) The number of known plants species in the world and its annual increase. Phytotaxa 261:201-217. https://doi.org/10.11646/phytotaxa.261.3.1

DGSV-DCNRF (2019) Gusano soldado *Mythimna unipucta*. Dirección General de Sanidad Vegetal Dirección del Centro Nacional de Referencia Fitosanitaria, Tecámac.

Dodson CH, Escobar Restrepo R (1993) Native Ecuadorian Orchids (vol. 1), Dodson Trust Sarasota.

Dressler R (2005) How many orchid species? Selbyana 26:155-158. http://www.jstor.org/stable/41760186

EPMAPS (2011) En las faldas inmensas de un monte…Las laderas occidentales de la ciudad de Quito. Juan Espinoza Paez, Quito. [online] URL:

https://www.isbnecuador.com/catalogo.php?mode=detalle&nt=29807

Fajardo O, Serna F (2006) Biología de *Peridroma saucia* (Lepidoptera: Noctuidae: Noctuinae) en flores cultivadas del híbrido comercial de *Alstroemeria* spp. Revista Facultad Nacional de Agronomía de Medellín 59:3435-3448.

Ferguson DC (2008) Geometroidea, Geometridae (part): Ennominae (part): Abraxini, Cassymini, Macariini. In: Hodges RW, et al. (eds) The Moths of North America, fasc. 17.2. The Wedge Entomological Research Foundation, California, pp 1-431.

Gerlach G, Schill R (1991) Composition of Orchid Scents Attracting Euglossine Bees. Botanica Acta 104:379-384. https://doi.org/10.1111/j.1438-8677.1991.tb00245.x

Goswami P, Bhattacharjee S, Bhattacharjee S (2024) Global research contributions on orchids: A scientometric review of 20 years. Journal of Applied Biology & Biotechnology 12:268-275. http://doi.org/10.7324/JABB.2024.170023

Holland WJ (1905) The moth book; a popular guide to a knowledge of the moths of North America. Doubleday, Page & company, New York.

Janes J K, van der Voort GE, Huber DPW (2024) We know very little about pollination in the *Platanthera* Rich (Orchidaceae: Orchidoideae). Ecology and Evolution 14: e11223. https://doi.org/10.1002/ece3.11223

Lafontaine JD, Sullivan JB (2009) A review of the genus *Megalographa* Lafontaine and Poole (Lepidoptera: Noctuidae: Plusiinae) with the description of a new species from Costa Rica. Insecta Mundi 77:1-10.

Meekers T, Honnay O (2011) Effects of habitat fragmentation on the reproductive success of the nectar-producing orchid *Gymnadenia conopsea* and the nectarless *Orchis mascula*. Plant Ecology 212:1791-1801. https://doi.org/10.1007/s11258-011-9949-4

Murren CJ (2002) Effects of habitat fragmentation on pollination: pollinators, pollinia viability and reproductive success. Journal of Ecology 90:100-107. https://doi.org/10.1046/j.0022-0477.2001.00638.x

Newman B, Ladd P, Brundrett M, Dixon KW (2013) Effects of habitat fragmentation on plant reproductive success and population viability at the landscape and habitat scale. Biological Conservation 159:16-23. https://doi.org/10.1016/j.biocon.2012.10.009.

Nowak S, Szlachetko D, Mytnik J (2014) New Species of the Genus *Altensteinia* (Orchidaceae, Spiranthoideae) from Colombia. Polish Botanical Journal 59:11-14. https://doi.org/10.2478/pbj-2014-0015.

Pellegrino G, Bellusci F (2014) Effects of human disturbance on reproductive success and population viability of *Serapias cordigera* (Orchidaceae), Botanical Journal of the Linnean Society 176:408-420. https://doi.org/10.1111/boj.12204

Pogue M (2009) Three New Cryptic Species within the *Dargida procinctus* (Grote) Complex (Lepidoptera: Noctuidae: Hadeninae) from the Neotropics. Proceedings of the Entomological Society of Washington 111:686-697. https://doi.org/10.4289/0013-8797-111.3.686

Phillips RD, Reiter N, Peakall R (2020) Orchid conservation: from theory to practice. Annals of Botany 126:345-362. https://doi.org/10.1093/aob/mcaa093.

Quispe CF, Singer R (2024) Reproductive biology in *Gomphichis valida* Rchb. f. (Orchidaceae: Orchidoideae, Cranichidinae): Generalist pollination in a high-Andean terrestrial orchid with long-lived flowers. Plant Species Biology 39:153-166. https://doi.org/10.1111/1442-1984.12453

Reina-Rodríguez G, Rubiano Mejía J, Castro Llanos F, Soriano I (2017) Orchid distribution and bioclimatic niches as a strategy to climate change in areas of tropical dry forest in Colombia. Lankesteriana 17:17-47. http://dx.doi.org/10.15517/lank.v17i1.27999

Rewicz A, Jaskuła R, Rewicz T, Tończyk G (2017). Pollinator diversity and reproductive success of *Epipactis helleborine* (L.) Crantz (Orchidaceae) in anthropogenic and natural habitats. PeerJ 5:e3159. https://doi.org/10.7717/peerj.3159

Salazar G (2005) Orquídeas. Diversidad Biológica e inventarios. Departamento de botánica instituto de Biología UNAM, México.

Salazar G (2009) DNA, morphology, and systematics of *Galeoglossum* (Orchidaceae, Cranichidinae). In: Pridgeon A M, Suarez JP (eds) Proceedings of the Second Scientific Conference on Andean Orchids. Universidad Técnica Particular de Loja, Loja, pp 161-172.

Seaton PT, Hu H, Perner H, Pritchard HW (2020) Ex situ conservation of orchids in a warming world. The Botanical Review 76:193-203. https://doi.org/10.1007/s12229-010-9048-6

Swarts ND, Dixon KW (2009) Terrestrial orchid conservation in the age of extinction. Annals of Botany 104:543-556. https://doi.org/10.1093/aob/mcp025

Tao Z, Ren, Z, Bernhardt P, Wang W, Huan L, Li H, Wang H. (2018) Nocturnal hawkmoth and noctuid moth pollination of *Habenaria limprichtii* (Orchidaceae) in sub-alpine meadows of the Yulong Snow Mountain (Yunnan, China). Botanical Journal of the Linnean Society 187:483-498. https://doi.org/10.1093/botlinnean/boy023

Tofangsazi N, Cherry RH, Meagher R, Arthurs SP (2014) Tropical Sod Webworm (Lepidoptera: Crambidae): a Pest of Warm Season Turfgrasses. Journal of Integrated Pest Management 5:C1-C8. https://doi.org/10.1603/IPM14014

TROPICOS (2023) Missouri Botanical Garden. [online] URL: https://www.tropicos.org/name/23505899

Trujillo D (2013) Diversidad de orquídeas de las diferentes formaciones vegetales de los andes peruanos. Lankesteriana International Journal on Orchidology 13:103-111. https://doi.org/10.15517/lank.v0i0.11546

Warren W (1896) New species of Drepanulidae, Thyrididae, Uraniidae, Epilemidae, and Geometridae in the Tring Museum. Novitates Zoologicae 3:335-419. https://doi.org/10.5962/bhl.part.5427

Wraith J, Norman P, Pickering C (2020) Orchid conservation and research: An analysis of gaps and priorities for globally Red Listed species. Ambio 49(:1601-1611. https://doi.org/10.1007/s13280-019-01306-7

Yurtsever S, Okyar Z, Güler N (2010) What colour of flowers do Lepidoptera prefer for foraging? Biologia 65:1049-1056. https://doi.org/10.2478/s11756-010-0125-4

ISSN 1920-7603