



**HONG KONG
GOLF CLUB**

Old•New•Eden
O.N.E. living heritage

Representation in respect of The Draft Fanling/Sheung Shui Extension Area OZP No. S/FSSE/1

June 2023

Moths of Fanling Golf Course

Baseline surveys of 2018, 2020 and 2022-2023

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Background: EcolA – Minimum Requirements

- “provide **sufficient** and **accurate** ecological data to allow a **complete** and **objective** identification, prediction and evaluation of the potential ecological impacts”
(§1.2 of Annex 16 to the TM)
- Required to provide an “**adequate** and **accurate** ecological **baseline** information”
(§5.1.1 of Annex 16 to the TM and §2(iv) of Appendix H to the SB)
- §2(iv)(c) of Appendix H to the SB requires the establishment of the ecological profile of the assessment area based on information collected, and major information to be provided shall include “**dominant species found, species diversity and abundance of major taxa groups, community structure, seasonal patterns, ecological value, interdependence of the habitats and species**”.
- §2(v)(g) of Appendix H to the SB further requires an **investigation and description in the existing wildlife uses of various habitats** with special attention to those wildlife groups and habitats with conservation importance, including macroinvertebrates, including **moths**.

Background: EcoIA – Minimum Requirements

- Planning Dept. responses (re ecology 04 R-S-FSSE-1 Annex IV, Paras A5; D1-D6), all based on a scientifically flawed EcoIA with regard to moths and light pollution
- Lack of sufficient literature review upon which scientifically valid methods for a baseline moth survey and habitat use survey should take place
- AFCD moth survey in HK (2004) used 125W mercury vapour [mv] light traps for baseline survey; Kendrick (2002) PhD survey data used 125W mv traps; HKU survey for non-native moth fauna (2021 & 2022) used 125W mv traps; Prof Wang Min used 450W mv & tungsten blended light for baseline moth survey at Yinggeling, Hainan, Aug/Sept 2005

Background: EcoIA – Minimum Requirements

TM & SB Requirements	Minimum Standards [1]	Met by EcoIA	Met by HKGC survey
Literature review	Complete review of all information	No moth recording method cited, very limited HK literature and no collections cited; no light pollution lit. cited; no ecological analysis methods cited	Complete for moths' recording and ecology, key HK lit. & collections reviewed; essential lit. for light pollution; key analysis methods cited.
Moth Baseline methodology	125W MV light source; daytime transect; Larval searching & rearing; Pheromone & bait methods	None of these methods undertaken	125W light traps with abundance samples, traps sited to account for habitat usage; from dusk for 3 to 4 hours; limited nocturnal larval searches
Moth Habitat Use methodology	Low wattage actinic light source, abundance data at each trap	From dusk for 2 hours, (AI, also midnight for 2 hours) abundance data recorded but not presented	Not undertaken

[1] – see references, slides 17 - 19

Background: EcolA – Minimum Requirements

TM & SB Requirements	Minimum Standards [1]	Met by EcolA	Met by HKGC survey
Seasonality	Every month, preferably weekly, all year	No dry season data (Nov-March),	Missing April, June & September
Flight periodicity	All night for light trapping	Dusk+ for two hours, midnight+ for 2 hours in AI	Dusk+ 3 to 4 hours
Weather & lunar cycle (for nocturnal recording)	Low wind, high % relative humidity, high % cloud cover, right temp., avoid full moon	Not recorded, so don't know if considered, high impact on outcome	Documented and factored in where possible
Scientifically valid analyses and data presentation	<ol style="list-style-type: none"> 1. diversity statistics (α, β, γ) 2. species richness estimation 3. habitat comparison 4. ecological relationships 5. species conservation status 	<p>None undertaken except for citing other sources on species conservation status (not actually undertaking assessments with standard methodology); raw moth data not presented in full - failure of due process as required in TM</p>	<ol style="list-style-type: none"> 1. None 2. Yes 3. Yes (site similarity) 4. Limited 5. Yes (global and local)

Overall

- **729** moth species (out of a known **2,675** spp. in HK) are documented in the three baseline surveys
- **107 Species of Conservation Concern [SCC]** found, out of approx. 250 SCC in HK:
 - **16 described** Hong Kong **endemics** (i.e. only found in HK, nowhere else in the world),
 - **41** further species of **international concern**
 - 50 species of local concern



2018 (Wet Season) Surveys

- July & August 2018, 8 sessions
- 6 recording sites, including Sub-Area 2 and Sub-Area 4
- 371 species recorded in generally poor conditions for light trap recording of moths during the mid-wet-season lull in adult moth activity
- **8 SCC of global conservation significance**, a further 21 SCC of regional and local conservation significance, 26 SCC that are unidentified, likely undescribed scientifically and for which no conservation assessment data is available. (total: 53 SCC)
- It appears that, despite routine management of the site, viable populations of many species of local, regional and global conservation significance still occur at all three of the courses (Old, New and Eden).

2020 (Transitional seasons) Surveys

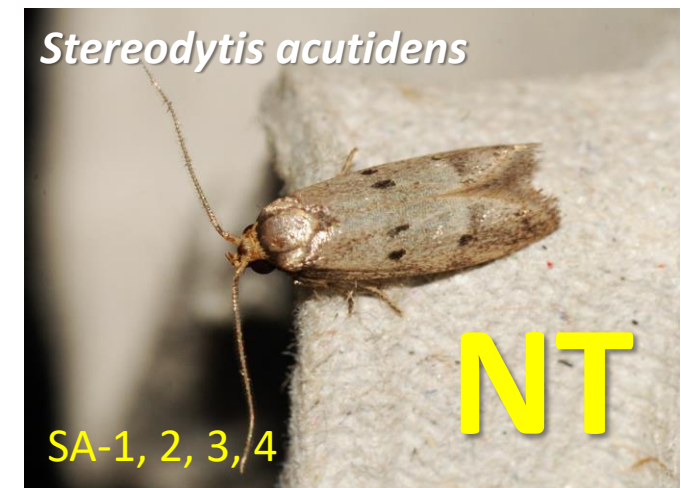
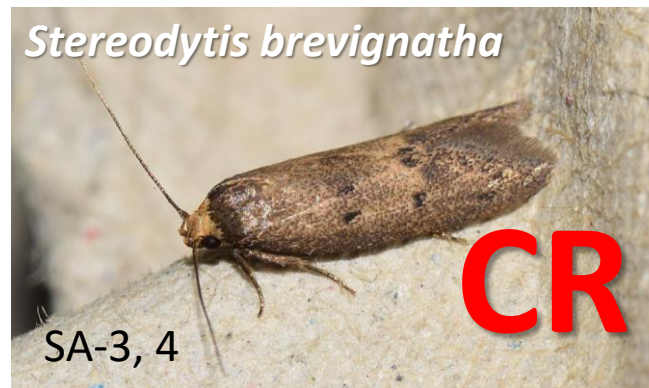
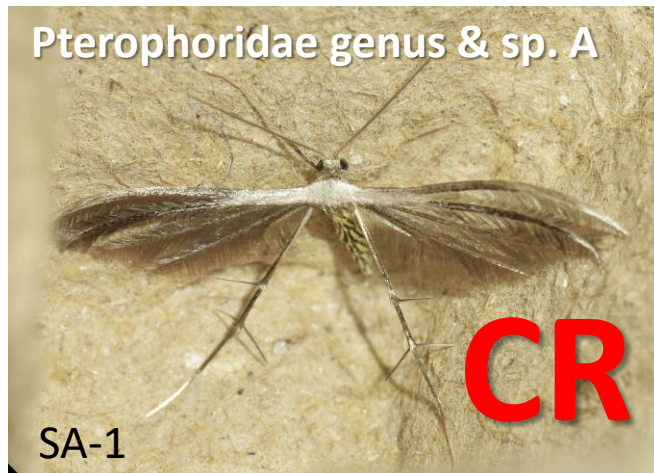
- May & October (6 sessions, Sub-Areas 1, 2 & 4)
- **406 species were recorded**, including **2 species new to Hong Kong**, and at least one unique (likely undescribed) species to FGC. Of the scientifically described species, **8 are endemic to Hong Kong**, all of which meet International Union for the Conservation of Nature [IUCN] Red List criteria for species at risk, or greater threat, of extinction globally. There are a further **25 SCC** of international and **14 SCC** of local conservation concern, giving a **total of 47 SCC**.
- The 2020 survey data, added 222 species to that from the 2018 survey, to **620** (593 in the report, but increased since then due to taxonomic updates) species
- 2018 & 2020: **SCC to 70 species** - **10 described Hong Kong endemics**, **38 further species of international concern** and **22 species of local concern**.

2022-2023 (Dry Season) Surveys

- Sub-Area 1: Monthly; October through March
- Sub-Area 2: December, January, March
- Sub-Area 3: October, November, February
- 323 species recorded; 34 moth species of conservation concern.
- Of the scientifically described species, **12 are endemic to Hong Kong** and **2 are nearly endemic to Hong Kong**.
- **Additionally: 14 international SSC, and 6 local SCC**
- A further 14 species are data deficient, suspected to be undescribed species currently not known outside Hong Kong.
- 2018, 2020 & 2022-2023: **107 SCC** :
 - **16 described Hong Kong endemics**,
 - **41** further species of **international concern**, and
 - 50 species of local concern.

Some Highlights:

All are of global conservation concern (IUCN Red List criteria for categories CR, EN, VU, NT):



- **264** moth species, of which **82 spp.** were found nowhere else in the EIA study site
- **44** moth SCC, out of the 107 moth SCC recorded at Fanling Golf Course
- 7 are species of ***global conservation concern***, a further 12 are rare or very rare species in Hong Kong and an additional 25 species are of local conservation concern

Incomplete Baseline Data

- These data are found with incomplete baseline surveying (none April, June or September), in mostly sub-optimal weather conditions.
- unaccounted for in **all** moth sampling undertaken to date at FGC -
 - All species that :
 - are active by day, or pre-dawn;
 - do not respond to light traps;
 - have to be sought by searching for larvae;
 - Are found by attracting to lures or baits.

(these 4 ecological subsets are estimated to be some 40% of the HK moth fauna, currently in the region of 2,675 moth species documented and estimated to be in excess of 4,000 species)

- or species whose flight season was missed by the surveying that took place;
- or species that are active only in the calmest of weather.

Local Context

Table of sites in HK with high moth diversity, including number of species of conservation concern. 125W mercury vapour light trap data.

Site	Habitat(s)	Elevation Range (m)	No. of Species	No. of pIUCN SCC	SSC as % of no. of species	No. of Recording events
Fanling Golf Course	Grassland, mixed & secondary forest	30-50	729	57	7.82	26
Kadoorie Centre, HKU, Shek Kong	Secondary forest	190-250	1411	56	3.97	169
Kadoorie Farm & Botanic Garden	Secondary forest	160-650	1528	48	3.14	104
Tai Po Kau Headland Conservation Area	Secondary forest	55-65	824	35	4.25	30
Sai Kung, Chuk Yeung Road	Secondary forest	190-210	510	27	5.29	10
Tai Po, Lam Tsuen, San Tsuen	Abandoned agriculture, village fringe, shrubland, fung shui wood	50	921	27	2.93	118
Tai Po, Lam Tsuen, Ng Tung Chai	Secondary forest	135	571	23	4.03	7
Tai Po, Lam Tsuen, Tai Yeung Che	Mixed agriculture, village fringe, shrubland, secondary forest	60	767	22	2.87	82
Nam Chung Valley	Secondary forest & abandoned agriculture	25-150	368	19	5.16	8

What is Light Pollution?

- Longcore & Rich (2004) reviewed ecological light pollution issues, defining types of light pollution as (i) *light trespass*; (ii) *over-illumination*; (iii) *glare*; (iv) *light clutter* and (v) *from satellites*.
- The first four of these types contribute to significant, mostly negative, impacts upon ecological, physiological and behavioural attributes of flora and fauna (including humans).
- The issue is very significant in Hong Kong, with the city being named the world's most light polluted city in 2016.
- Only a voluntary guidelines document produced in 2015 by the Task Force on External Lighting, despite the Task Force's chairman stating "inaction is not an option".

What is Light Pollution?

The available literature now extends to over 4,300 publications available online via the Artificial Light At Night [ALAN] Research Literature Database, covering ecological, medical, social and astronomical impacts of ALAN.

Light pollution impacts negatively upon at least the following topics (source: International Dark-Sky Association): Wildlife & ecosystems; energy (and hence CO2 emissions); crime and security; night sky heritage; human health.

ALAN is becoming recognised by many countries as a serious impediment to these topics and being addressed with action & legislation.

Specific impacts on moths:

- Increased moth mortality by predators at lights;
- Interruption to lunar cycles, breeding ability and foraging ability;
- Local population extinctions in the short-term; large-scale population decreases and extinction in the long term suspected (meta-population dynamics interrupted)

References #1 – Moth Recording (General)

Moth recording.

- Bowden, J. & Morris, M.G., 1975.** The influence of moonlight on catches of insects in light-traps in Africa. Part III. The effective radius of a mercury vapour light trap and analysis of catches using effective radius. *Bulletin of Entomological Research* **65**: 303-348. - clues as to how far away a moth might respond to light
- Baker, R.R. & Sadovy, Y., 1978.** The distance and nature of the light-trap response of moths. *Nature* **276**: 818-821. - more clues as to how far away a moth might respond to light
- Muirhead-Thompson, R.C., 1991.** *Trap Responses of Flying Insects - The Influence of Trap Design on Capture Efficiency*. Academic Press, London. 304 pp.
- Fry, R. & Waring, P., 1996.** A guide to moth traps and their use. *The Amateur Entomologist* **24** . iv + 60. - Sets out the standard methods used to undertake baseline surveys and habitat based ecological surveys; includes comparison of light types (tungsten, actinic, mercury vapour) and trap types.

Factors affecting nocturnal moth activity & recording (moon, time of night, weather, trap types)

- Bowden, J., 1982.** An analysis of factors affecting catches of insects in light traps. *Bulletin of Entomological Research* **72**: 535-556.
- Bowden, J. & Church, B.M., 1973.** The influence of moonlight on catches of insects in light-traps in Africa. Part II. The effect of moon phase on light-trap catches. *Bulletin of Entomological Research* **63**: 129-142.
- Butler, L.; Kondo, C.; Barrows, E.M. & Townsend, E.C., 1999.** Effects of weather conditions and trap types on sampling for richness and abundance of forest Macrolepidoptera. *Environmental Entomology* **28**: 795–811.
- Jonason D; Franzén M & Ranius T, 2014.** Surveying moths using light traps: effects of weather and time of year. *PLoS ONE* **9** (3): e92453. <https://doi.org/10.1371/journal.pone.0092453>
- Nowinszky, L.; Mészáros, Z. & Puskás, J., 2007.** The hourly distribution of moth species caught by a light trap. *Applied Ecology and Environmental Research* **5**: 103-107.
- Siddorn, J.W. & Brown, P.S., 1971.** A Robinson light trap modified for segregating samples at predetermined time intervals, with notes on the effect of moonlight on the periodicity of catches of insects. *Journal of Applied Ecology* **8**: 69-75.
- Williams, C.B., 1935.** The times of activity of certain nocturnal insects, chiefly Lepidoptera, as indicated by a light trap. *Transactions of the Royal Society of London* **83**: 523-556.

References #2 – Moth Recording (HK), Ecology, Data Analysis

Hong Kong Moth Recording

Kendrick, R.C., 2002. *Moths (Insecta: Lepidoptera) of Hong Kong*. Ph.D. thesis, The University of Hong Kong. xvi + 660 pp - PhD on moth recording in Hong Kong; covers baseline sampling, distribution, seasonality, species conservation assessment and habitat associations; covers some 1800 species, notes on identification.

Ades, G.W.J. & Kendrick, R.C.; (eds.), 2004. *Hong Kong Fauna: A Checklist of Selected Taxa*. Kadoorie Farm & Botanic Garden, Tai Po, Hong Kong. 86 pp. - The only published checklist of Hong Kong's moths. Now very outdated (many more species, much change in taxonomy and nomenclature - hundreds of literature items for this)

Species Conservation Assessment in Hong Kong

Kendrick, R.C., 2007. The Conservation Assessment of Moths in Hong Kong. pp. 71-82 in Kendrick, R.C. (ed.), *Proceedings of the First South East Asian Lepidoptera Conservation Symposium, Hong Kong 2006*. Kadoorie Farm & Botanic Garden, Tai Po, Hong Kong.

Data Analysis

Krebs, C.J., 2009. *Ecology: The Experimental Analysis of Distribution And Abundance (6th ed.)*. Cummings, San Francisco. xvi + 655 pp. - All the necessary ecological experimental design and data analysis needed

Magurran, A.E., 1988. *Ecological Diversity and its Measurement*. Springer, Dordrecht. x + 179 pp - Provides key approaches to how much data is needed to understand a baseline sample strategy and an ecological assemblage, and then how to analyse the data - diversity indices, comparing samples, estimation of species richness

General moth ecology

Lees D.C. & Zilli, A., 2019. *Moths. Their biology, diversity and evolution*. Natural History Museum, London. 208 pp. - the most recent standard introductory text on moth ecology, documenting the multiple ecological roles and strategies used by moths and thus the need for so many baseline recording methods.

References #3 – Key Light Pollution References

Impact of light pollution (in general and upon moths)

Frank, K.D., 1988. Impact of outdoor lighting on moths: an assessment. *Journal of the Lepidopterists' Society* **42** : 63-93.

Longcore, T. & Rich, C., 2004. Ecological light pollution. *Frontiers in Ecology and the Environment* **2** : 191-198.

The Royal Commission of Environmental Pollution, 2009. *Artificial Light in the Environment* . The Stationery Office. U.K. 43pp.

Macgregor, C.J., Evans, D.M., Fox, R. & Pocock, M.J.O., 2017. The dark side of street lighting: impacts on moths and evidence for the disruption of nocturnal pollen transport. *Global Change Biology* **23** : 697-707.

Wakefield, A., Broyles, M., Stone, E.L., Harris, S. & Jones, G., 2018. Quantifying the attractiveness of broad spectrum street lights to aerial nocturnal insects. *Journal of Applied Ecology* **55** : 714-722.

Boyes, D.H., Evans, D.M., Fox, R., Parsons, M & Pocock, M.J.O., 2020. Is light pollution driving moth population declines? A review of causal mechanisms across the life cycle. *Insect Conservation and Diversity* . doi: 10.1111/icad.

Retain OU (CR) for all the 32 ha under consideration

- Even though the HKGC baseline moth survey data must be regarded as preliminary, the high incidence of moth species of global conservation concern is indicative of the high and internationally significant ecological value of Fanling Golf Course as a whole.
- Precautionary Principle is applicable – there are many moth species likely of conservation concern found at FGC, even in Sub-Area 1, which require substantial investigation into their taxonomy and ecology before any decision on change of land use should be made.
- From these three baseline moth surveys, it is evident that the whole area under consideration should be retained as OU (CR) to conserve the internationally significant moth assemblages, the flora upon which they depend, and the fauna that depend upon the moths, found at Fanling Golf Course.