Butterflies Species Richness and Diversity in Panti Forest Eco-Park, Johor, Malaysia

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Abstract. This study thoroughly examines butterfly diversity in the Panti Forest Eco-Park, Johor, Malaysia. Data collected from November 2017 to July 2018 involved the use of aerial nets and baited traps along a 1 km transect, resulting in 207 individuals of 75 species. The Nymphalidae family was most prevalent, representing 152 individuals across 49 species. The rank abundance curve highlighted *Iambrix stellifer* and *Lexias pardalis dirteana* as the most abundant species. Notably, 37 species were solitary occurrences, making up 49.3% of the entire sample. Several singleton species were identified, including *Dichorragia nesimachus deiokes* (Nymphalidae), *Danaus melanippus hegesippus* (Nymphalidae), *Gandaca harina distanti* (Pieridae), and *Eooxylides tharis distanti* (Lycaenidae). The calculated H′ Index of 4.004 and EH value of 0.9218 indicate high butterfly diversity, positioning the Panti Forest Eco-Park as one of Johor's most diverse locations. Variations in dominant families compared to earlier works may be due to sampling methods. Additionally, the attraction of *Lexias pardalis dirteana* to baited traps emphasizes the importance of methodological considerations in butterfly diversity assessments. Furthermore, compared to prior research, a lower species count was observed, attributed to the exclusion of the bunker trail as a sampling site.

1 Introduction

Johor, Malaysia is rich in biodiversity, but exhibits a landscape of relatively fragmented forest areas. Therefore, researchers need to continue investigating the remaining forested areas, particularly in terms of biodiversity conservation [1]. Anthropogenic activities remain one of the biggest challenges to biodiversity in Peninsular Malaysia, particularly in the state of Johor. Understanding the ecological dynamics within these forested areas allows us to better understand and plan for a more effective conservation strategy. In this context, our study focuses on the butterfly diversity within Panti Forest Eco-Park as it is one of the biggest forest islands in the state of Johor. This puts it second only to the Endau Rompin landscape. This forest reserve is an invaluable reservoir of biodiversity. Butterflies are well known for their ability to act as bioindicators due to their quick reproductive rates, small size, and

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sensitivity to environmental changes [2]. Sulaiman *et al.* have previously done an extensive study on the butterflies in Panti Forest Eco-Park, recording 83 butterfly species [3]. Our study aims to update this checklist. Other biodiversity surveys done here include herpetofauna [4], moss [5] odonates [6], and aquatic insects [7].

2 Methodology

2.1 Study Site

Panti Forest Eco-Park (N 1°47′21.134″, E 103°56′29.777″) is located within Panti Forest Reserve that spans over 13,410 ha of forested area. The forest reserve is situated in Central Johor, southern to the state (Figure 1). The survey was done between November 2017 to July 2018.
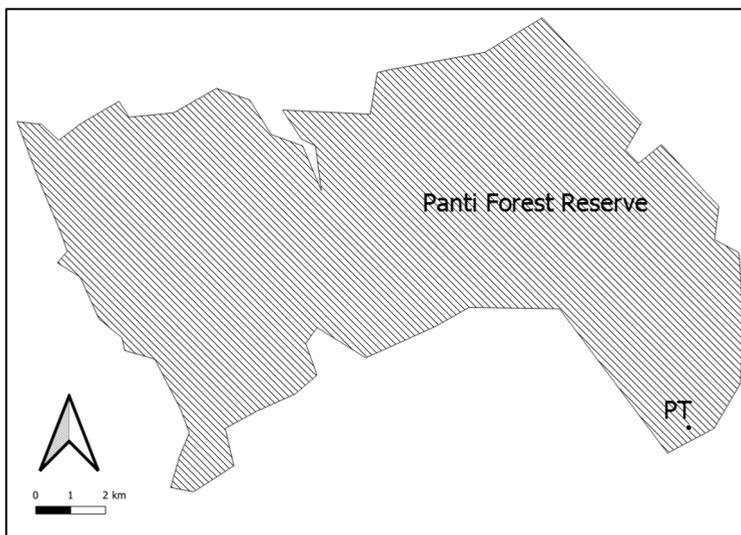

Fig. 1. An overview of Panti Forest Reserve, pinpointing the sampling area labeled PT.

2.2 Sampling Design

Samples of butterflies representing their diversity in the area were systematically collected via active sampling using aerial nets and passive sampling using baited traps. The active sampling were done through a simple random sampling approach. The aerial net sampling was conducted along a 1 km transect between 0900 to 1700 hours when butterflies are most active. Eleven checkpoints (CP0 to CP10) were established along the transect, each tagged with a GPS coordinate for precise location identification. To complement this method, baited traps were strategically placed along the transect, starting from CP1 onwards, with a distance of 100 m between each trap. These traps were hung on a tree at a height at 1.5 m from the ground, and baited with decaying banana and pineapple mixture. The manual collection of butterflies occurred within a 10 m radius on either side of the traps along the transect, as illustrated in Figure 2.
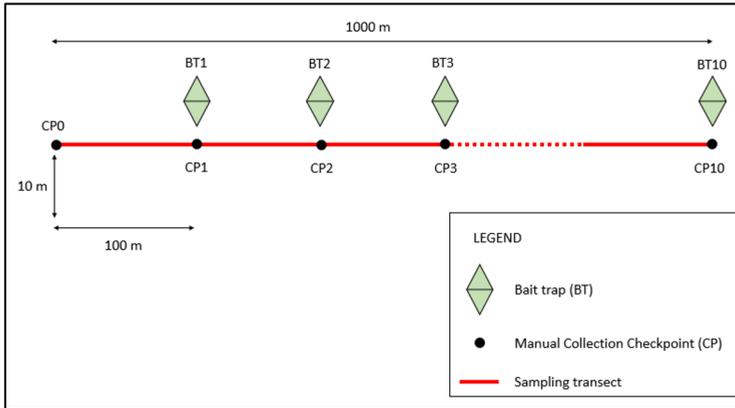
Fig. 2. Transect design.

Captured butterflies were immobilized by carefully pinching the thorax using the thumb and forefinger. Glassine envelopes with the size of 4' x 5' were used to store the butterflies temporarily. After each sampling session, the specimens were transported to the laboratory in Centre of Research for Sustainable Uses of Natural Resources (COR-SUNR) in Universiti Tun Hussein Onn Malaysia. In the controlled environment of the laboratory, each specimen underwent a standardized preservation process, which included softening, spreading, pinning, and drying. The spread specimens were then dried in a drying oven. The drying process were done for at least seven days at a set temperature of 40°C.

Butterfly species identification were referenced based on taxonomic keys, plates, photographs, and descriptions provided in Corbet & Pendlebury [8]. The identification process focused on key morphological features such as wing patterns, palpi, and sex organs. To aid identification, the wingspan was also measured from all curated samples starting from the tip of the left forewings.

To ensure species identification accuracy, we then sent the specimens for verification by taxonomists at the Forest Research Institute Malaysia (FRIM). We also examined the refence collection deposited at the Centre for Insect Systematic, Universiti Kebangsaan Malaysia (CIS-UKM) for species confirmation. Specimens that have been identified to species level were then deposited at the COR-SUNR repository.

2.3 Data Analysis

After species identification, diversity and species assemblage data were analyzed using Paleontological Statistics (PAST) [9]. Shannon Index of Diversity (H') were used to calculate the value for species diversity[10]. Equation 1 shows the Shannon Index of Diversity (H') formula that is used in this study:

$$H' = -\sum_{i=1}^{s} (p_i)(\ln p_i) \tag{1}$$

where
H' : Shannon Index of Diversity (H')
p_i : the ratio or proportion of individuals belonging to the ith species
s : number of species.

Shannon Index of Diversity (H') value may sit between higher value for communities with higher number of individuals and species, to 0 for communities with single species and individual. Usually, the value of H' may fall between 1.5 and 3.5. In some cases, the value can surpass 4 when the sample contain a larger number of species [10].

The Evenness Index (E_H) emphasizes the division of individuals within the overall sample. The Evenness Index ((E_H) may be calculated using the formula as per Equation 2:

$$E_H = \frac{H}{\ln S} \qquad\qquad (2)[10]$$

where:
E_H = Evenness Index,
H = Shannon Index of Diversity value
S = total number of species.

To interpret the value of Eveness (E_H) value, the assemblage with the most uneven abundance distribution among the individuals may obtain a value of 0. On the other hand, assemblages with an even distribution between number of individuals and species may get a value of up to 1. We must assess evenness as many of our species are singeltons, categorizing them as relatively 'rare'.

3 Results and Discussion

After a thorough analysis, we conclude that the butterfly assemblage in Panti Eco-Park is quite high for a forest of this size and location. The butterflies sampled accounted for 207 individuals comprising of 75 species in Panti Forest Eco-Park (Table 1).The fruit-feeding butterflies or Nymphalidae were the most specious species with 152 individual butterflies and 49 butterfly species recorded (Figure 3). This is comparable with Sulaiman *et al*. [3] who recorded 83 species during an expedition held by Johor State Forestry Department (JPNJ) in the year 2006 and 2007. During the expedition, the inventory covers the camping site and bunker trail. Since this study did not include the bunker trail as a sampling site, the number of species obtained was relatively lower.

Our study only recorded five families in Panti Forest Eco-Park namely Nymphalidae, Lycaenidae, Hesperiidae, Pieridae and Papilionidae. Butterflies from the metalmarks family or Riodinidae were not recorded here. The most abundance species based on the rank abundance curve was *Iambrix stellifer* (Hesperiidae)(Figure 4A) and *Lexias pardalis dirteana* (Nymphalidae) (Figure 4B) which recorded at least ten individuals for each species (Figure 5).

Based on the rank abundance curve, as much as 37 species are represented by single individuals or singletons. This accounted for 49.3% of the whole butterfly sample from Panti Forest Eco-Park. hirty-seven species were represented by singletons, which accounted for 49.3% of the whole sample. *Dichorragia nesimachus deiokes* (Nymphalidae) were amongst these singleton species. The same species were also mention by Corbet & Pendlebury [8] to be rare in Peninsular Malaysia. Other species that was recorded as singletons include *Danaus melanippus hegesippus* (Nymphalidae), *Gandaca harina distanti* (Pieridae), and *Eeoxylides tharis distanti* (Lycaenidae). The study also recorded *Arnetta verones* (Hesperiidae), *Isma protoclea obscura* (Hesperiidae), *Poritia sumatrae sumatrae* (Lycaenidae), *Melanitis phedima abdullae* (Nymphalidae), and *Parantica agleoides agleoides* (Nymphalidae) which are new record for Johor. The Shannon Index of Diversity (H') value for the butterfly assemblage in Panti Forest Eco-Park is 4.004 with an Evenness (E_H) value of 0.9218. Apart from Endau Rompin National Park, Panti Forest Reserve is also a well-known hotspot for butterfly enthusiasts mainly because of the high diversity there, as proven by this study.

Table 1. List of butterfly species present in Panti Forest Eco-Park

No.	Family	Scientific Name
1.	Papilionidae	*Graphium agamemnon agamemnon* (Linnaeus, 1758)
2.		*Graphium delessertii delessertii* (Guérin-Méneville, 1839)
3.		*Graphium evemon eventus* (Fruhstorfer, [1908])
4.		*Graphium sarpedon luctatius* (Fruhstorfer, 1907)
5.		*Papilio demolion demolion* Cramer, [1776]
6.	Pieridae	*Eurema ada iona* Talbot, 1939
7.		*Eurema hecabe contubernalis* (Moore, 1886)
8.		*Eurema sari sodalis* (Moore,1886)
9.		*Gandaca harina distanti* Moore, [1906]
10.		*Leptosia nina nina* (Fabricius, 1973)
11.	Nymphalidae	*Eulacera osteria kumana* Fruhstorfer, 1913
12.		*Agatasa calydonia calydonia*** (Hewitson, [1854])
13.		*Prothoe franck uniformis* Butler, 1885 **
14.		*Danaus melanippus hegesippus* (Cramer, [1777])
15.		*Chersonesia peraka peraka* Distant, 1884
16.		*Parantica agleoides agleoides* C. & R. Felder 1860 +
17.		*Ideopsis similis persimilis* (Moore, 1879)
18.		*Cirrochroa emalea emalea* (Guerin-Meneville, 1843)
19.		*Cirrochroa orissa orissa* C. & R. Felder, 1860
20.		*Cupha erymanthis lotis* (Sulzer, 1776)
21.		*Terinos atlita teuthras* Hewitson, 1862
22.		*Vindula erota chersonesia* (Butler,[1879])
23.		*Athyma kanwa kanwa* Moore, 1858
24.		*Bassarona dunya dunya* (Doubleday, [1848])
25.		*Bassarona teuta goodrichi* (Distant, 1886)
26.		*Dophla evelina compta* Fruhstorfer, 1899
27.		*Euthalia ipona* Fruhstorfer, 1913
28.		*Euthalia monina monina* (Fabricius, 1787)
29.		*Lasippa tiga siaka* (Moore, 1881)
30.		*Lexias pardalis dirteana* (Corbet, 1941)
31.		*Pantoporia sandaka sandaka* (Butler, 1892)
32.		*Phaedyma columella singa* (Fruhstorfer, 1899)
33.		*Tanaecia aruna aruna* (C. & R. Felder, 1860)
34.		*Tanaecia iapis puseda* (Moore, [1858])
35.		*Tanaecia munda waterstradti* Corbet, 1941
36.		*Tanaecia pelea pelea* (Fabricius, 1787)
37.		*Amathusia ochraceofusca ochraceofusca* Honrath, [1888]
38.		*Amathusia phidippus phidippus* (Linnaeus, 1763)
39.		*Amathuxidia amythaon dilucida* (Honrath, 1884)#
40.		*Faunis canens arcesilas* Stichel, 1933
41.		*Zeuxidia amethystus amethystus* Butler, 1865
42.		*Zeuxidia aurelius aurelius* (Cramer, [1777]) **
43.		*Zeuxidia doubledayi doubledayi* Westwood, [1851]
44.		*Junonia almana javana* C. Felder, 1862
45.		*Junonia atlites atlites* (Linnaeus, 1763)
46.		*Junonia hedonia ida* (Cramer, [1775])
47.		*Junonia orithya wallacei* Distant, 1883
48.		*Dichorragia nesimachus deiokes* [Fruhstorfer, 1913]
49.		*Melanitis leda leda* (Linnaeus, 1758)
50.		*Melanitis phedima abdullae* Distant, 1883
51.		*Mycalesis fusca fusca* (C. & R. Felder, 1860)
52.		*Mycalesis maianeas maianeas* Hewitson, [1864]

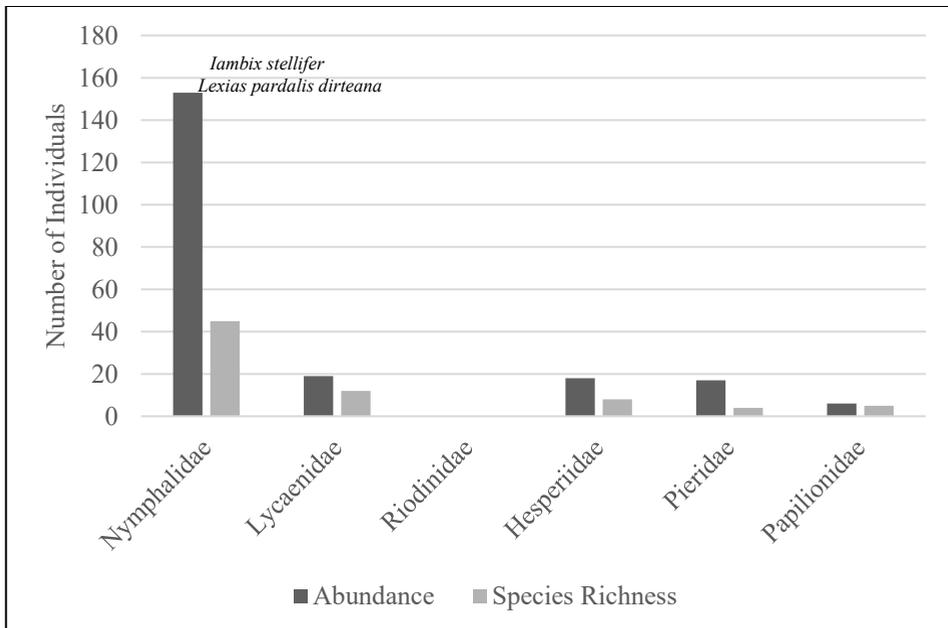| 53.		*Mycalesis mineus macromalayana* Fruhstorfer, 1911
54.		*Mycalesis orseis nautilus* Butler, 1867
55.		*Mycalesis perseus cepheus* Butler, 1867
56.		*Mycalesis visala phamis* Talbot & Corbet, 1939
57.		*Orsotriaena medus cinerea* (Butler, 1867)
58.		*Xanthotaenia busiris busiris* Westwood, [1858]
59.		*Ypthima baldus newboldi* Distant, 1882
60.	Lycaenidae	*Poritia sumatrae sumatrae* (Felder & Felder, 1865) +
61.		*Allotinus horsfieldi permagnus* Fruhstorfer, 1913
62.		*Jamides celeno aelianus* (Fabricius, 1793)
63.		*Prosotas bhutea* (de Niceville, [1884])
64.		*Arhopala abseus abseus* Hewitson, 1862
65.		*Arhopala major major* Staudinger, 1889
66.		*Drupadia ravindra moorei* (Distant, 1882)
67.		*Eooxylides tharis distanti* Riley, 1942
68.		*Neomyrina nivea periculosa* Fruhstorfer, 1913#
69.	Hesperiidae	*Tagiades gana gana* (Moore, [1886])
70.		*Arnetta verones* Hewitson, 1878
71.		*Erionota harmachis* (Hewitson, 1878)
72.		*Gangara thyrsis thyrsis* (Fabricius, 1775)#
73.		*Iambrix salsala salsala* (Moore, [1866])
74.		*Iambrix stellifer* (Butler, [1879])
75.		*Isma protoclea obscura* Distant, 1886
(**) The species is protected under Wildlife Conservation Act 2010, Act 716		
(#) Corbet & Pendlebury [8] considers this species rare in Peninsular Malaysia		

Fig. 3. Graph showing the richness and abundance of butterfly species in Panti Forest Eco-Park, separated based on family
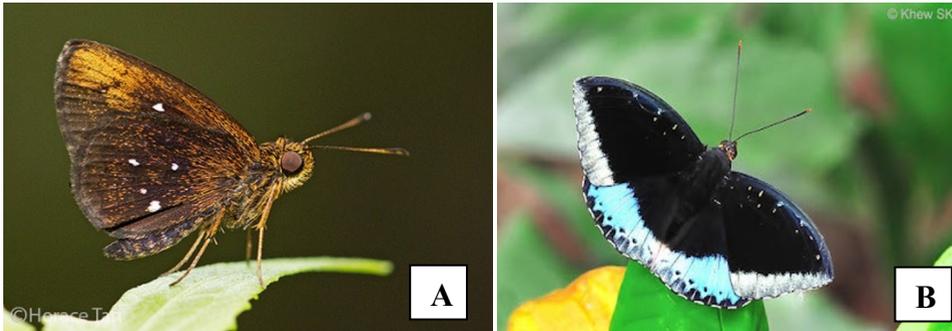
Fig. 4. A. *Iambrix stellifer* (Hesperidae), **B.** *Lexias pardalis dirteana* (Nymphalidae) (Source: Nature Society (Singapore) Butterfly List).
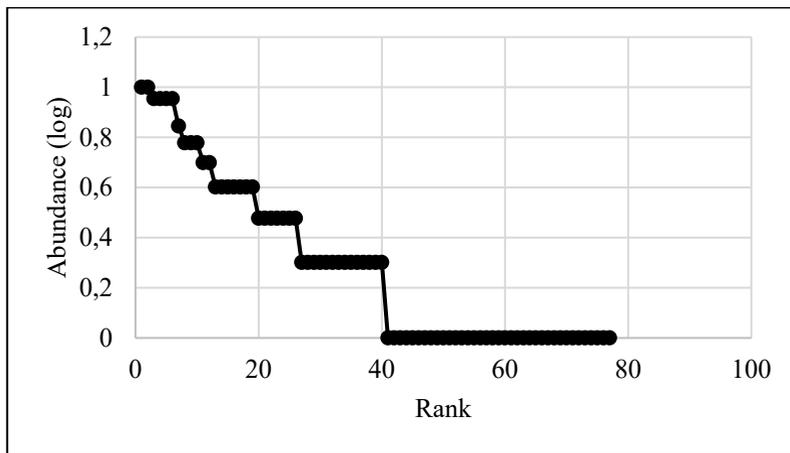

Fig. 5. Diversity of butterflies in Panti Forest Eco-Park as depicted via the rank abundance curve

It is not surprising that many of the species recorded in this study are from the family Nymphalidae. Our combination of active and passive sampling using aerial nets supplemented by baited traps are the main cause of this pattern of abundance. In Peninsular Malaysia, Corbet & Pendlebury [8] reported that family Lycaenidae to be the most species-rich family, followed by Nymphalidae. However, our results are more closely aligned with those of Ismail [11], who utilized a similar sampling approach involving both active sampling via aerial net and passive sampling via baited traps. The utilization of baited traps may have also contributed to *Lexias pardalis dirteana* being the most abundant species in this study. The species appears to exhibit a strong attraction to the banana-pineapple mixture used in the baited traps.

4 Conclusion

The Panti Forest Eco-Park showcases a rich variety of butterflies dominated by the Nymphalidae family. The exclusion of the bunker trail from our sampling influenced the observed species count, aligning with prior studies. Notably, the reserve harbors protected and rare species, alongside new records for Johor, highlighting its ecological importance. The H′ Index (4.004) and EH value (0.9218) indicate a high butterfly diversity comparable to

renowned sites. The difference in dominant families and the prevalence of *Lexias pardalis dirteana* in baited traps suggests the impact of sampling methods in butterfly assessments. In conclusion, the Panti Forest Reserve stands as a vital butterfly hotspot, reinforcing its role in Malaysian biodiversity conservation.

References

1. S. A. Scriven, C. M. Beale, S. Benedick, J. K. Hill Biotropica, **49** (2017)

2. K. Syaripuddin Utility of Bats (Chiroptera) as Ecological Indicators in Peninsular Malaysia (Master Thesis, Universiti Malaya, Institute of Biological Sciences, 2014)

3. N. Sulaiman, M. N. Mohd Nafi, S. M. Ishak, M. Abdullah, *Butterfly Fauna (Lepidoptera: Rhopalocera) of Panti Forest Reserve* in Siri Kepelbagaian Biologi Hutan : Hutan Simpan Panti, Johor - Pengurusan Hutan, Persekitaran Fizikal dan Kepelbagaian Biologi, **11** (Kuala Lumpur: Jabatan Perhutanan Semenanjung Malaysia, 2009)

4. C. Kin Onn, L. L. Grismer, M. Matsui, K. Nishikawa, P. L. Wood, J. L. Grismer, D. Belabut, N. Ahmad, Trop. Life. Sci. Res., **21**, 1, (2010)

5. A. Damanhuri, F. Ag. Kanak, H. Maideen, A. A. Rahman, L. G. Ee, and N. Norhazrina *Flora lumut jati di Hutan Simpan Panti* in Siri Kepelbagaian Biologi Hutan : Hutan Simpan Panti, Johor - Pengurusan Hutan, Persekitaran Fizikal dan Kepelbagaian Biologi, **11** (Kuala Lumpur: Jabatan Perhutanan Semenanjung Malaysia, 2009)

6. M. A. A. Abdul Aziz Diversity, Species Composition and Distribution of Odonates (Odonata) in Johor State, Peninsular Malaysia (Master Thesis, Universiti Tun Hussein Onn Malaysia, 2018)

7. M. Z. Zakaria, Diversity of Aquatic Insects at Several Water Bodies in Johor (Master Thesis, Universiti Tun Hussein Onn Malaysia, 2019)

8. A. S. Corbet, H. M. Pendlebury, G. M. Van Der Poorten, and N. E. Van Der Poorten, The Butterflies of the Malay Peninsula (UK, Southdene, 2020)

9. D. A. T. Hammer, P. D. Ryan, Ø. Hammer, D. A. T. Harper, Past: Paleontological Statistics Software Package for Education and Data Analysis (2001) [Online]. Available: http://palaeo-electronica.orghttp://palaeo-electronica.org/2001_1/past/issue1_01.htm

10. A. E. Magurran, Ecological Diversity and Its Measurement, **1** (Dordrecht, Springer Netherlands, 1988)

11. N. Ismail, M. Mohamed, K. Mohd Salleh, P. C. Khim, L. Tokiman, J. of Wildlife and Parks, **33** (2018)