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Research Article

An Analysis of Butterfly Diversity in Kozluk District (Batman) and Their Preferences for Habitat and Altitude

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Abstract
Butterfly species are one of the indicator groups for biodiversity change and habitat monitoring. However, studies on butterfly species' habitat and altitude preferences have rarely been evaluated. A study was carried out on the species diversity of butterfly fauna in different habitats and altitudes from Kozluk district of Batman Province. The survey was conducted in 43 locations between 2020-2021. Evaluations were executed for 1.982 butterfly samples collected from the research area. 103 species are diagnosed in 7 families of butterfly; Argynnidae: 15, Libytheidae: 1, Lycaenidae: 34, Papilionidae: 4, Pieridae: 15, Satyridae: 19, Hesperiidae: 15. Among them, 64 species are newly recorded in Kozluk and 34 species in Batman. The species of *Libythea celtis* (Laicharting, 1782), together with its family Libytheidae, has been added to the fauna of Batman, and the number of butterfly species in Batman increased from 90 to 124. The altitude and habitat preferences of the specimens in the research area and the number of species in the locations of the families are presented and discussed. The majority of the species are determined in oak forests and riverside biotopes. Geçitaltı is the location with the highest number of species. The butterflies are mostly detected between 600-1000 m altitudes with a rate of 72% in the research area. This study is utilizable both to the specification of the distribution areas of the species and to the learning of their ecology.

1. Introduction

The first studies on the determination of the Turkish Lepidoptera fauna were carried out by foreign researchers such as Zeller [1], Lederer [2], and Staudinger [3]. Hesselbarth et al. [4] conducted the most thorough study on butterflies in Turkey, and 365 taxa were classified as a result. Turkey is inhabited by 414 species of butterflies, including recently discovered and newly described species [4-10]. Besides, especially after the 2000s, studies have been carried out, mostly by local researchers, to reveal the butterfly fauna of the Southeastern Anatolia Region of Turkey [9, 11-27].

The first research on Papilionoidea and Hesperioidea fauna in Batman Province started in Kozluk district with daily studies. There is not any relevant literature on Kozluk district and its surroundings beyond these studies. Hesselbarth et al. [4] reported *Hyponephele lupina* (Costa, [1836]) from Kozluk in their study titled "The Butterflies of Turkey". In 2008, Kemal et al. [12] listed 44 butterfly species from the district and presented five of them as new records for the fauna of the province. After that, research in the district led to the listing of 50 butterfly species [17]. According to Turkey's faunistic checklist [8], Kozluk has 66 butterflies. Moreover, Seven [19] added 4 species, and then 15 species [20] to the butterfly fauna of Batman Province. From the region, including Batman, *Pontia glauconome* (Klug, 1829) received its first record for Turkey [9]. In the West Raman Region of Batman, Seven and Aykal [25] discovered 33 species in total, 5 of which were new records for the province. These results increase the overall number of butterflies in Batman to 90.

In this paper, butterflies' habitat and altitude preferences were interpreted along with species diversity in the area. The research region comprises mainly dense and sparse mountain oak forests and, samples were mostly collected from these habitats. Surveys on the species' habitat and altitude preferences are relatively limited. Butterfly diversity changes in relation to habitats and elevations are an interesting and well-covered topic in ecology, but the effects of aspects have rarely been interpreted. This research conduces to the clarification of the ecological preferences of the species.

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2. Materials and Methods

Insect nets were used to catch the samples. The collected specimens were put into envelopes made of parchment paper after they were killed in jars containing ethyl acetate. The samples, which were enveloped at each location, were placed in packages with place names and dates. The materials were protected in naphthalene insect boxes. Then, the pinned and softened samples were stretched and dried as standard entomological museum material. Diagnoses were made based on external morphological features. For photographing the materials, the Fujifilm Finepix HS30 EXR camera was used. The specimens are preserved in the collection of the Entomology Laboratory in Batman University. Resources of Alberti [28], Evans [29], Hesselbarth et al. [4], Tolman [30], Tshikolovets [31] and, Wiemers et al. [32] were employed in diagnosis and terminology.

Materials were collected from 43 localities (Fig. 1, Table 1) ranging from approximately 600 m to 1700 m with field studies carried out 56 times between April 2020 and November 2021. The research was carried out in six habitat types: Agricultural land, mountain oak forest, creek edge, sparse oak barren, bush field, and stony areas (Fig. 2, Table 1). Some locations have been studied more intensively. Factors such as vegetation, road and safety conditions of the locations were effective in their studying rates.

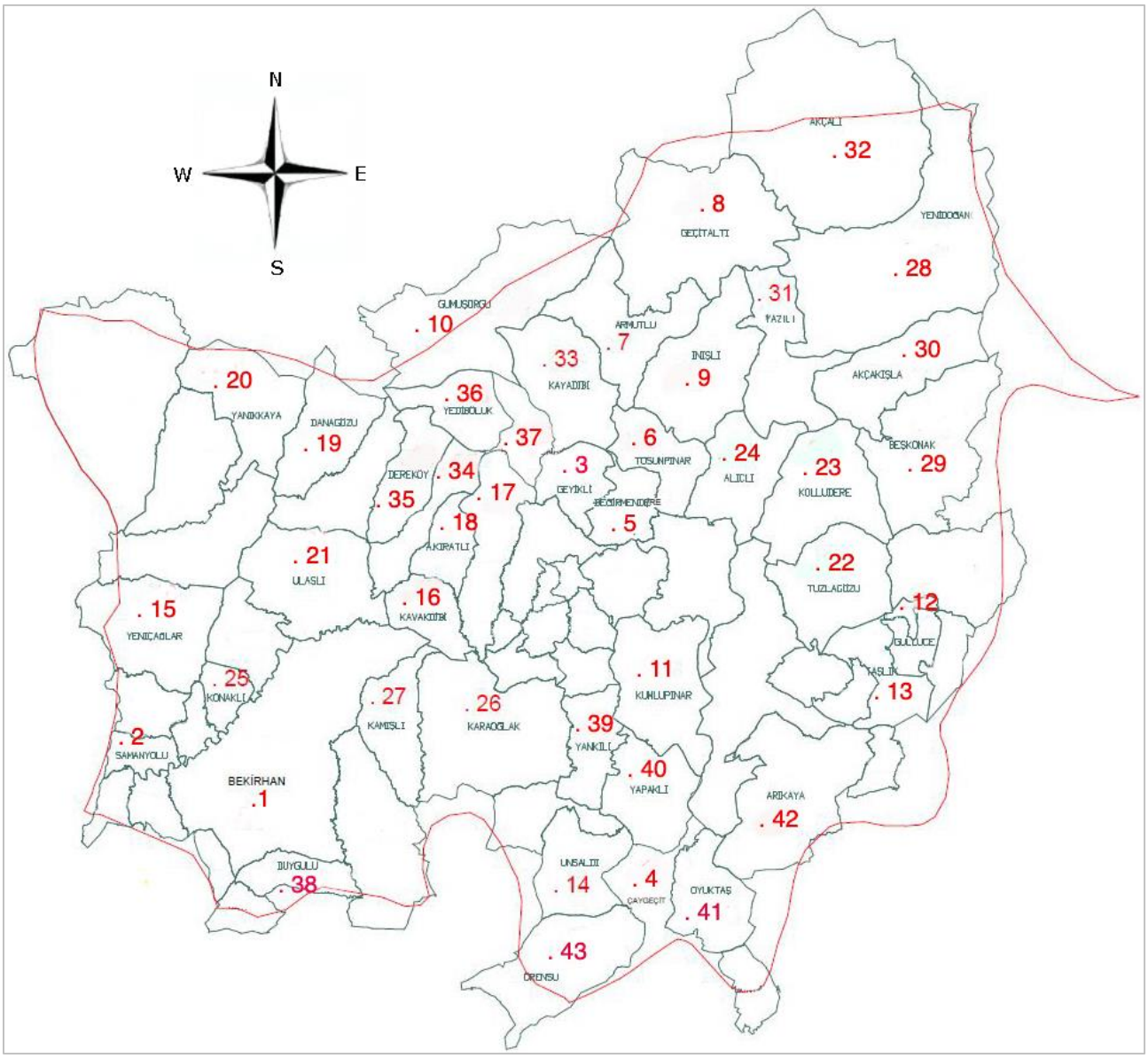

Figure 1. Map of Kozluk district and studied locations (Scale: 1/10000, TKGM)

Figure 2. Some studied locations in Kozluk district: **a.** Geyikli, 980 m, 15.04.2021; **b.** Geçitaltı, 1290 m, 28.05.2021; **c.** Alıçlı, 740 m, 15.05.2021; **d.** Yenidoğan, 885 m, 29.08.2021 (Photographs: M. Astan)

Table 1. Location data and habitat types

Location	Altitude (m)	Date	Coordinates	Habitat
1. Bekirhan	695	26.06.2020	38°10'01"N, 41°18'39"E	Agricultural land
2. Samanyolu	625	03.07.2020	38°06'37"N, 41°13'46"E	Creek edge
3. Geyikli (Cevizli)	980	03.07.2020, 27.04.2021	38°12'58"N, 41°26'27"E	Mountain oak forest
4. Çaygeçit	660	03.07.2020, 15.04.2021	38°04'18"N, 41°29'18"E	Creek edge
5. Değirmendere	800	14.07.2020	38°12'09"N, 41°28'38"E	Mountain oak forest
6. Tosunpınar	1075	25.07.2020, 25.09.2021	38°13'54"N, 41°28'37"E	Mountain oak forest
7. Armutlu	1225	07.08.2020, 29.07.2021, 07.10.2021	38°15'46"N, 41°28'39"E	Mountain oak forest
8. Geçitaltı	1290	14.08.2020, 28.05.2021, 02.10.2021, 07.10.2021	38°17'01"N, 41°28'57"E	Creek edge
9. İnişli	1200	21.08.2020, 04.09.2021	38°14'18"N, 41°29'50"E	Sparse oak barren
10. Gümüşörgü	1095	21.10.2020, 14.08.2021	38°15'53"N, 41°23'27"E	Mountain oak forest
11. Kumlupınar	615	27.03.2021	38°08'13"N, 41°31'11"E	Creek edge
12. Çayhan	700	07.04.2021	38°09'47"N, 41°36'04"E	Sparse oak barren
13. Taşlık	960	10.04.2021	38°07'30"N, 41°35'05"E	Sparse oak barren
14. Ünsaldı	690	12.04.2021	38°04'42"N, 41°25'03"E	Sparse oak barren
15. Yeniçağlar	645	13.04.2021	38°08'51"N, 41°14'07"E	Stony area
16. Kavakdibi	760	20.04.2021	38°10'10"N, 41°21'52"E	Sparse oak barren
17. Gündüzlü	870	20.04.2021	38°11'41"N, 41°24'44"E	Bush field
18. Aşağıkıratlı	890	21.04.2020	38°11'44"N, 41°22'42"E	Stony area
19. Danagözü	965	21.04.2021	38°14'17"N, 41°19'08"E	Stony area
20. Yanıkkaya	1080	21.04.2021, 08.09.2021	38°14'52"N, 41°18'18"E	Stony area
21. Ulaşlı	730	29.04.2021	38°10'45"N, 41°19'20"E	Sparse oak barren
22. Tuzlagözü	895	15.05.2021	38°10'54"N, 41°34'20"E	Sparse oak barren
23. Kolludere	880	15.05.2021	38°11'37"N, 41°32'58"E	Mountain oak forest
24. Alıçlı	740	15.05.2021	38°12'28"N, 41°31'29"E	Creek edge
25. Konaklı	680	17.05.2021	38°09'16"N, 41°19'27"E	Sparse oak barren
26. Karaoğlak	720	17.05.2021	38°06'31"N, 41°23'16"E	Sparse oak barren
27. Kamışlı	695	17.05.2021	38°06'00"N, 41°21'27"E	Sparse oak barren
28. Yenidoğan	885	10.06.2021, 29.08.2021	38°16'26"N, 41°34'12"E	Mountain oak forest
29. Beşkonak	1390	26.06.2021	38°14'27"N, 41°37'19"E	Mountain oak forest

Location	Altitude (m)	Date	Coordinates	Habitat
30. Akçakışla	1100	29.06.2021	38°15'47"N, 41°36'33"E	Mountain oak forest
31. Yazılı	815	08.07.2021, 22.08.2021	38°15'08"N, 41°32'43"E	Mountain oak forest
32. Akçalı	1720	13.07.2021	38°18'41"N, 41°35'18"E	Mountain oak forest
33. Kayadibi	1400	07.08.2021	38°15'54"N, 41°26'26"E	Mountain oak forest
34. Yukarıkıratlı	1300	08.09.2021	38°13'11"N, 41°23'18"E	Mountain oak forest
35. Dereköy	1280	12.09.2021	38°13'32"N, 41°22'36"E	Mountain oak forest
36. Yedibölük	1280	16.10.2021	38°14'08"N, 41°22'50"E	Mountain oak forest
37. Bölükkonak	1100	24.10.2021	38°13'21"N, 41°25'06"E	Mountain oak forest
38. Duygulu	615	03.11.2021	38°03'54"N, 41°19'53"E	Sparse oak barren
39. Yankılı	690	07.11.2021	38°06'20"N, 41°27'11"E	Sparse oak barren
40. Yapaklı	645	07.11.2021	38°05'52"N, 41°29'15"E	Creek edge
41. Oyuktaş	610	13.11.2021	38°02'49"N, 41°29'52"E	Bush field
42. Arıkaya	675	13.11.2021	38°04'12"N, 41°32'14"E	Sparse oak barren
43. Örensu	600	18.11.2021	38°01'38"N, 41°27'18"E	Sparse oak barren

3. Results and Discussion

In this paper, 103 species were found in 7 families from Kozluk district. The overall number of these species in Batman Province has increased from 90 to 124 as a result of the registration of 34 new species. *Libythea celtis*, which is represented by a single species in Libytheidae family in Turkey, is newly discovered in the province (Table 2, 3).

Table 2. Comparison of the number of butterfly species in the families

Family	Known species in Batman	Number of species found in Kozluk	New records for Batman	The total number for Batman
Argynnidae	15	15	6	21
Libytheidae	-	1	1	1
Lycaenidae	29	34	9	38
Papilionidae	2	4	2	4
Pieridae	12	15	5	17
Satyridae	18	19	4	22
Hesperiidae	14	15	7	21
Total	**90**	**103**	**34**	**124**

Lycaenidae, with 34 species, has the greatest number of species in the research region. Satyridae family, which contains 19 species, is the next. Hesperiidae, Pieridae, and Argynnidae have 15, Papilionidae has 4, and Libytheidae has 1 species (Fig. 3).

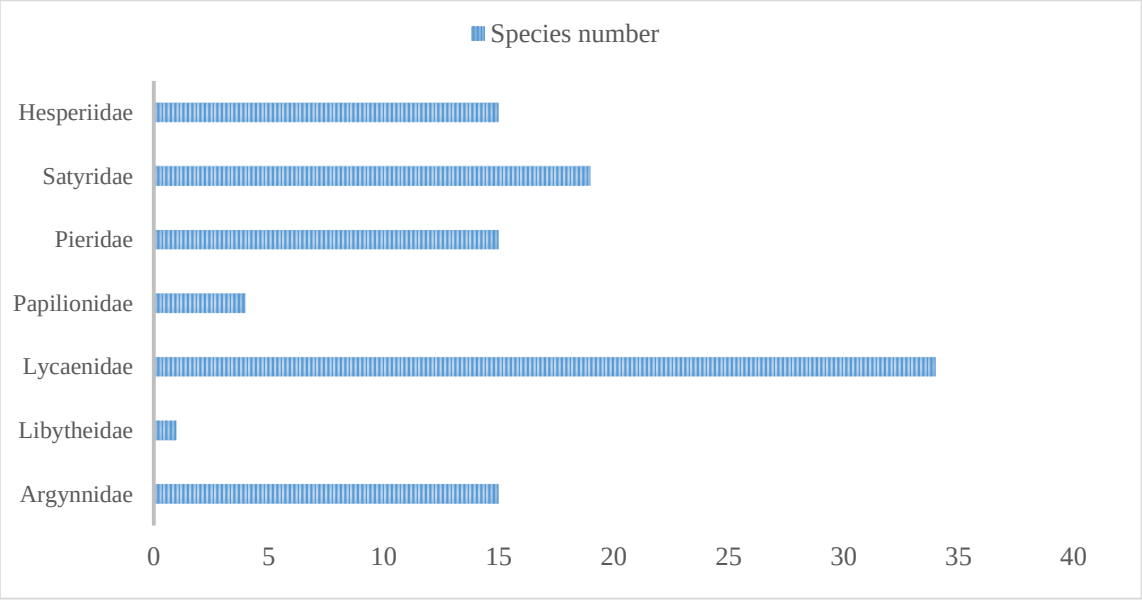

Figure 3. Species number in the families

The study area includes mostly mountain oak forests and sparse oak biotopes (see Table 1). Therefore, the majority of the species were collected from *Quercus* spp. forests and streamside habitats. Argynnidae family was generally identified from mountainous and creekside sites. Specimens of *Libythea celtis* were detected in oak habitats and collected from altitudes between 1250-1800 m a.s.l. Members of Lycaenidae were mostly determined in mountainy, creek edge, and stony habitats. The captured butterflies in the family of Papilionidae were commonly found in natural and bush fields and, specimens were caught at 600-900 m a.s.l. Pieridae samples were diagnosed from mountain oak forests, creek edges, and sparse oak biotopes. The vertical distribution scale of the species in this family is high. Individuals belonging to Satyridae family were gathered from mountainous areas, streamside, and sparse oak barren. Hesperiidae specimens were largely caught in mountainous regions and near streams (Table 3).

Table 3. Species list and their habitat and altitude preferences (**1:** Agricultural land, **2:** Mountain oak forest, **3**: Creek edge, **4**: Sparse oak barren, **5**: Bush field, **6**: Stony area, ***** : new records for Batman)

Family		Species	1	2	3	4	5	6	Altitude (m)
Argynnidae	1.	*Argynnis niobe**			■				1250-1500
	2.	*A. pandora*		■					850-1750
	3.	*A. paphia**		■	■				800-900
	4.	*Issoria lathonia** (Fig. 4a)		■	■			■	750-1300
	5.	*Limenitis reducta*		■	■				800-1500
	6.	*Melitaea collina**			■				750-850
	7.	*M. ornata**			■				800-900
	8.	*M. persea*			■				750-850
	9.	*M. phoebe*			■				750-850
	10.	*M. syriaca*			■				800-900
	11.	*Nymphalis xanthomelas*			■				800-900
	12.	*Polygonia c-album**		■					800-1000
	13.	*P. egea*		■					1000-1100
	14.	*Vanessa atalanta*		■	■				600-1100
	15.	*Vanessa cardui*	■	■	■	■	■	■	600-1400
Libytheidae	16.	*Libythea celtis**		■	■	■			1250-1800
Lycaenidae	17.	*Celastrina argiolus*		■	■			■	600-1100
	18.	*Cigaritis uighurica*		■	■				1250-1500
	19.	*Cupido osiris**	■		■				600-700
	20.	*Glaucopsyche alexis*			■				750-900
	21.	*G. lessei*			■				700-800
	22.	*Lampides boeticus*		■	■			■	700-1700
	23.	*Lycaena alciphron*		■	■			■	800-900
	24.	*L. asabinus**		■	■			■	900-1700
	25.	*L. kefersteinii*		■	■			■	700-1400
	26.	*L. kurdistanica*		■	■			■	900-1400
	27.	*L. phlaeas*		■	■			■	800-1300
	28.	*L. tityrus*		■	■			■	800-1400
	29.	*Plebejus carmon*		■	■			■	800-1300
	30.	*Polyommatus alcedo**		■					800-1000
	31.	*P. amandus*	■	■	■				1300-1500
	32.	*P. agestis*		■	■			■	600-1700
	33.	*P. bellargus*		■				■	800-1100
	34.	*P. bellis**			■				700-900
	35.	*P. demavendi*		■	■				800-1000
	36.	*P. daphnis**		■	■				800-1100
	37.	*P. icarus*	■	■	■		■	■	800-1700
	38.	*P. isauricus**	■						700-900
	39.	*P. loewii*		■	■				700-1100
	40.	*P. poseidon**		■	■				600-1100
	41.	*P. thersites*		■					800-1000
	42.	*Pseudophilotes vicrama*		■	■				1300-1500
	43.	*Satyrium abdominalis*		■	■				800-1300
	44.	*S. marcidum*			■				700-900
	45.	*S. spini**		■	■				1300-1500
	46.	*S. zabni*		■					1100-1300
	47.	*Tarucus balkanicus*		■	■				800-1500

	48.	*Tomares callimachus**	600-700
	49.	*Turanana endymion*	800-1000
	50.	*Zizeeria karsandra*	600-800
Papilionidae	51.	*Archon apollinaris**	600-700
	52.	*Iphiclides podalirius**	800-900
	53.	*Papilio machaon*	700-800
	54.	*Zerynthia deyrollei* (Fig. 4b)	600-900
Pieridae	55.	*Anthocharis cardamines*	700-1000
	56.	*Aporia crataegi*	1200-1500
	57.	*Colias alfacariensis**	800-1300
	58.	*C. crocea* (Fig. 4c)	600-1500
	59.	*Colotis fausta* (Fig. 4d)	600-700
	60.	*Euchloe ausonia*	600-800
	61.	*Gonepteryx farinosa*	1200-1500
	62.	*Pieris brassicae**	800-1500
	63.	*P. ergane*	600-1500
	64.	*P. mannii*	600-1100
	65.	*P. persis**	800-1500
	66.	*P. pseudorapae**	600-1500
	67.	*P. rapae**	600-1500
	68.	*Pontia chloridice*	700-1800
	69.	*P. edusa*	700-1500
Satyridae	70.	*Brintesia circe* (Fig. 4e)	800-1800
	71.	*Chazara briseis**	1200-1300
	72.	*Coenonympha pamphilus*	700-1800
	73.	*C. saadi*	700-1000
	74.	*Hipparchia parisatis**	1000-1200
	75.	*H. syriaca*	1000-1200
	76.	*Hyponephele lupina*	1100-1500
	77.	*H. lycaon*	1100-1400
	78.	*H. wagneri*	1100-1200
	79.	*Kirinia roxelana*	800-1800
	80.	*Lasiommata maera**	1300-1800
	81.	*L. megera*	800-900
	82.	*Maniola jurtina*	700-1800
	83.	*M. telmessia*	1300-1500
	84.	*Melanargia grumi*	800-1500
	85.	*M. syriaca**	800-1500
	86.	*Pararge aegeria* (Fig. 4f)	800-1800
	87.	*Pseudochazara anthelea*	1100-1200
	88.	*P. pelopea*	1100-1800
Hesperiidae	89.	*Carcharodus alceae*	700-1500
	90.	*C. lavatherae*	1100-1500
	91.	*C. orientalis*	1300-1500
	92.	*Erynnis marloyi*	1100-1200
	93.	*Muschampia nomas*	1300-1500
	94.	*M. poggei*	600-1800
	95.	*M. proteides**	1100-1500
	96.	*M. tersa**	1100-1300
	97.	*M. tessellum**	1300-1500
	98.	*Pyrgus armoricanus**	1100-1300
	99.	*P. serratulae**	700-1500
	100.	*Spialia orbifer*	700-800
	101.	*S. phlomidis**	700-800
	102.	*Thymelicus lineolus**	1100-1500
	103.	*T. sylvestris*	700-1500

Field studies in Kozluk district were carried out at 43 locations (see Table 1). Of these, Geçitaltı (Site: 8) is the habitat with the highest number of species. The number of studies and plant diversity are thought to be the reasons for the identified species diversity in this location. Moreover, Kayadibi (Site: 33), Yenidogan (Site: 28), Yazılı (Site: 31), and Tosunpınar (Site: 6) are rich in species diversity. Although Kayadibi was studied once, it attracted attention with the detection of a very high number of species (Table 4).

The butterflies are mostly found (at a rate of 72%) between 600-1000 m a.s.l. in the research area (Table 5). The considerable plant diversity between these meters can be used to explain this condition. The ecosystems between these altitudes typically consist of valleys and stream sides. There is a minor decrease in the number of species between 1000-

1400 meters, and there is a decrease in the number of species beyond 1400 meters. This condition is believed to be the result of less research and longer working hours in high-altitude settings. It turns out that whereas Argynnidae, Lycaenidae, Papilionidae, and Pieridae species are mostly seen at 600-1000 m a.s.l., Hesperiidae, Libytheidae, and Satyridae families are diagnosed at 1000-1400 m a.s.l.

Table 4. The species number of families in locations (**Arg**: Argynnidae, **Lib**: Libytheidae, **Lyc**: Lycaenidae, **Pap**: Papilionidae, **Pie**: Pieridae, **Sat**: Satyridae, **Hes**: Hesperiidae, for sites see Table 1)

Site	Arg	Lib	Lyc	Pap	Pie	Sat	Hes	Total
1	-	-	3	-	-	-	-	**3**
2			5		2		1	**8**
3	3	-	-	-	1	5	-	**9**
4	1	-	5	2	4	-	-	**12**
5	-	-	9	-	4	1	1	**15**
6	1	-	12	-	7	5	2	**27**
7	-	-	4	-	7	3	2	**16**
8	4	1	16	-	8	9	9	**47**
9	1	1	11	-	6	1	4	**24**
10	2	-	7	-	7	5	-	**21**
11	1	-	1	-	3	-	-	**5**
12	-	-	2	-	2	3	1	**8**
13	-	-	4	-	1	2	-	**7**
14	1	-	2	2	2	-	-	**7**
15	1	-	2	-	2	-	-	**5**
16	2	-	2	1	4	-	-	**9**
17	-	-	5	-	4	-	-	**9**
18	2	-	1	1	5	-	-	**9**
19	-	-	6	-	2	-	-	**8**
20	1	-	9	-	6	-	4	**20**
21	1	-	2	1	4	-	2	**10**
22	3	-	3	-	2	1	1	**10**
23	1	-	2	-	1	-	-	**4**
24	-	-	5	1	3	3	1	**13**
25	4	-	-	1	3	1	1	**10**
26	1	-	3	-	1	1	-	**6**
27	1	-	1	-	4	-	1	**7**
28	4	-	11	1	6	8	-	**30**
29	2	-	4	-	6	4	1	**17**
30	-	-	4	-	3	1	1	**9**
31	5	-	8	-	6	6	1	**26**
32	1	1	4	-	3	7	-	**16**
33	3	-	10	-	8	3	6	**30**
34	2	-	5	-	3	2	1	**13**
35	1	-	6	-	2	2	3	**14**
36	1	-	4	-	3	3	1	**12**
37	2	-	2	-	3	1	2	**10**
38	2	-	1	1	4	-	-	**8**
39	-	-	-	1	3	-	-	**4**
40	-	-	-	2	-	-	-	**2**
41	-	-	-	-	2	-	-	**2**
42	-	-	-	-	4	-	-	**4**
43	-	-	1	-	4	-	-	**5**

Table 5. Numerical distribution of species depending on the altitude (**Arg**: Argynnidae, **Lib**: Libytheidae, **Lyc**: Lycaenidae, **Pap**: Papilionidae, **Pie**: Pieridae, **Sat**: Satyridae, **Hes**: Hesperiidae)

Altitude (m)	Arg	Lib	Lyc	Pap	Pie	Sat	Hes	Total
600-1000	13 (% 12,6)	- (% 0)	30 (% 29,1)	4 (% 3,8)	12 (% 11,6)	9 (% 8,7)	6 (% 5,8)	74 (% 71,6)
1000-1400	6 (% 5,8)	1 (% 0,9)	21 (% 20,3)	- (% 0)	11 (% 10,6)	16 (% 15,5)	13 (% 12,6)	68 (% 65,7)
1400-1800	3 (% 2,9)	1 (% 0,9)	9 (% 8,7)	- (% 0)	9 (% 8,7)	11 (% 10,6)	10 (% 9,7)	43 (% 41,5)

The research region's fauna was not represented well in earlier studies. The number of butterflies in Kozluk and the province as a whole was far from being accurately given by the data collected through daily studies and for specific species. That is why a thorough program has been used to study the topic. It is believed that the Papilionoidea and Hesperioidea superfamilies will contribute to the fauna of Batman Province and the Turkish fauna in this regard. The study's findings are crucial for comprehending the richness of butterflies in Batman Province. In addition to these, it will help determine the habitat and altitude preferences of species as well as the areas where the species are found.

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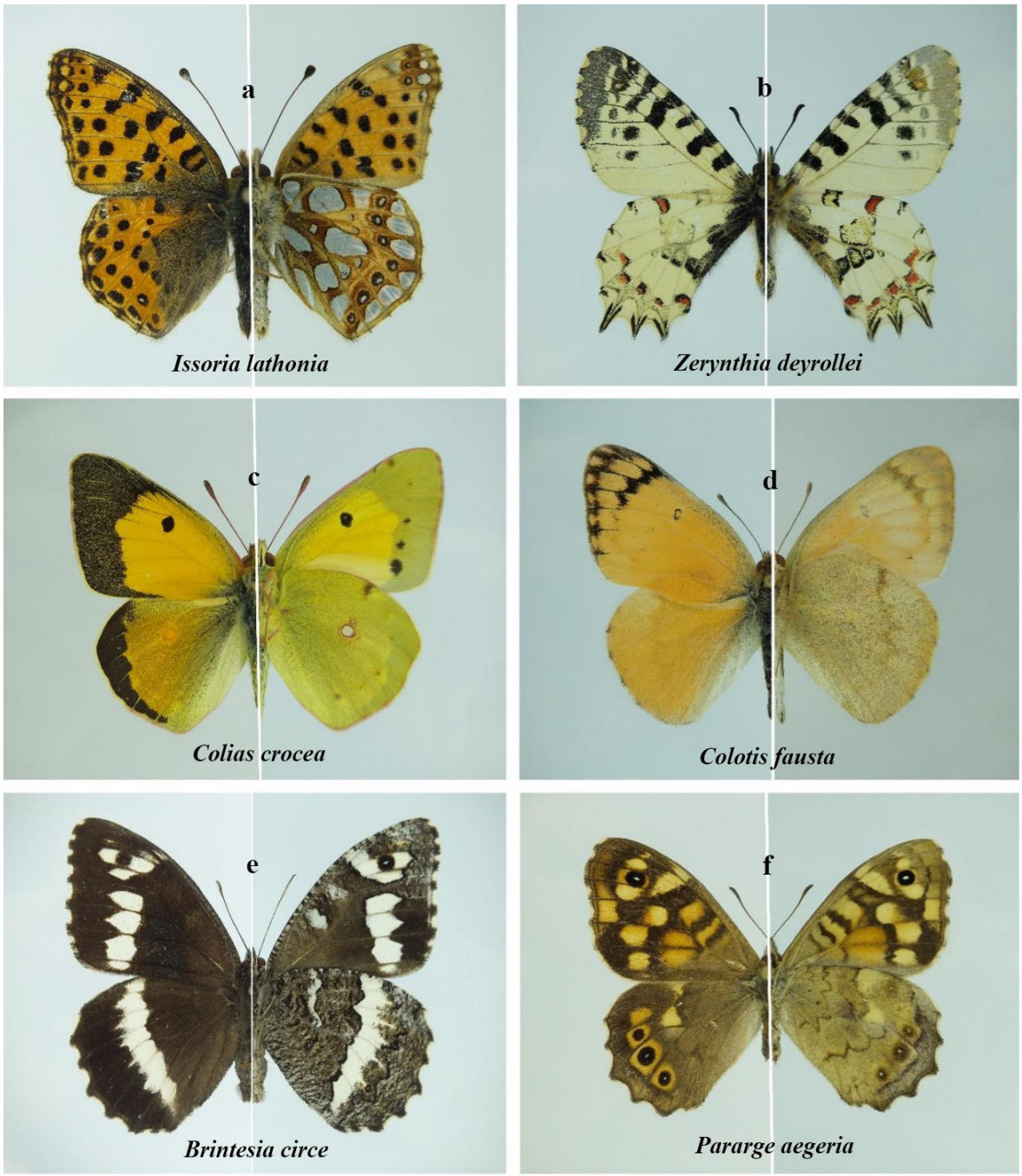

Figure 4. Stretched some butterfly species with upperside (left) and underside (right) (Photographs: E. Seven)

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