Butterflies of the North Red Sea - New Records and an Annotated Checklist

(Lepidoptera, Rhopalocera) by

DUBI BENYAMINI & GÜNTER MÜLLER received 31.III.2020

Abstract: Recent discoveries of Afro-Tropical butterflies new to the north Red Sea mountain ranges and the Rift Valley are highlighted enumerating every species in five listed families (Table 1); Papilionidae – two species, Nymphalidae (incl. Satyrinae) – 4 species, Pieridae – 5 species (including one new subspecies), Lycaenidae – 3 species and Hesperiidae – 5 species. It adds 7 species to the Egyptian list, in addition to the recently found *Chilades pandava* (FRIC et al. 2014) and *Calopieris eulimene* (EL-GABBAS & GILBERT, 2016) and 6 species to N Hejaz in NW Saudi Arabia, one of them *C. eulimene* (EL-GABBAS & GILBERT) is already known from Egypt, In spite of our limited butterfly records in these remote areas we can speculate with great certainty that the appearance of such numbers of new species is closely related to the intensification of Red Sea Troughs (RST), high altitude cross African jet streams and NW Indian Ocean cyclones. These meteorological events of huge air-mass movements and tropical storms that originate respectively in eastern Sub-Saharan/Sahel zones in Sudan (RST), , and across Africa and southern Arabia. These RSTs may have carried with them some of the new-recorded species while moving northwards or northeast to the southeastern Mediterranean. An annotated checklist of the species found in this crossroad area between Africa, Asia and Arabia is provided.

Introduction: Since the early 2000's the first author of the current study concentrated his efforts on summarizing his life-time project "Butterflies of the Levant" (BENYAMINI, D. & E. JOHN, in prep). During this period, a large amount of species information was accumulated about the southern extended Levant. Added to it was information about eastern Egypt's coastal Red Sea Mountains and the Halaib Triangle ("Jebel Elba"), as well as the mountain chain of north-west Saudi-Arabia in Hejaz to the classical southern Levant of Jordan, Israel, the northern Mediterranean region of Egypt and the Sinai Peninsula. While these classical areas were treated thoroughly by several publications (BENYAMINI, 1984, 2001, 2002a, 2002b, 2002c, 2017b; BENYAMINI & JOHN, 2020; LARSEN 1983, 1990, 2015; LARSEN & NAKAMURA, 1983; PITTAWAY, 1985)), the northern Red Sea areas where Africa, Asia and Arabia come into contact did not get equivalent attention and remained one of the least studied zones. As such, this crossroad deserves separate treatment, which is given in this publication. It includes the addition of 10 species to the known fauna of Egypt, which increases the current species assemblage by 18.5%. In the parallel eastern side of the Red Sea, in northwestern Saudi Arabia (Hejaz), 8 species were added to the faunal assemblage, enlarging the number of recorded species in this remote zone by 22.8%. These new additions expand the known distribution of 12 species by hundreds of kilometers to the north. Lack of previous sufficient data from these mountain ranges prevent us from determining the exact time when they became populated by new Ethiopian / Afro-tropical species. However, we can speculate that the drastic growth of intensity and frequency of Red Sea Troughs, tropical storms that originated in Sudan and southwestern Arabia, are likely the reason for the movement of some species. The increased amount of precipitation caused by these weather patterns enhances the growth of available host-plants, and enables these new species to establish permanent populations. If these phenomena, a derivative of the greenhouse effect will continue, we may expect not only the desertification of the eastern Mediterranean, but further arrival and establishment of additional Afro-Tropical/Saharo-Arabian butterfly species (BENYAMINI, 2017a; 2017b).

The new records from the Northern Red-Sea countries are from the following areas:

Eastern Egypt: From the Sudanese border at parallel 22° north, and the Halaib Triangle (Gebel Elba, 1.435 m) north along the coastal plains and mountain range with peaks over 2.000 m, the large wadies of eastern Egypt (i.e. Wadi El Gemal Natural Reserve), across Marsa Alam and Hurghada to Suez. While "average annual rainfall in the region is less than 50 mm (2.0 in), the orographic precipitation in and around Gebel Elba itself amounts to as much as 400 mm (16 in), in the upper areas", (Wikipedia). **Sinai Peninsula**: From the southern tip at Ras Muhamed and Sharm El-Sheikh, northwards across Gebel Katherine Massif peak at 2.637 m. Includes the western coastal plain of the Gulf of Suez. The eastern coastal plain of the Gulf of Aqaba and Eilat to the north Sinai Mediterranean coastline at latitude ~31° N. The butterfly fauna includes 48 species.

Hejaz (Northwest Saudi Arabia): The north-west coastal plain north of Yanbu with its main city Haql, Tabuk Province, as well as the northwestern Hejaz mountain range from Gebel Dafdaf to the Jordanian border at Gebel Um-Adami with its peak at Gebel el-Lawz (2.580 m). The butterfly fauna includes at least 43 species.

Southern Israel - South of Latitude ~31°N: This region is composed of the southern Arava within the Rift Valley and the southern Negev mountains. This inverted triangle with a 53 km base north of Eilat, includes 56 species, mostly desert and rift valley migratory species (Table 1). Southern Jordan: - South of Latitude ~30°N (BENYAMINI, 2000) the southern Arava within the Rift Valley. Includes the southern Edom mountain peak at ~1.750 m. Also includes the Hisma Basin (FABIANO, 1998)) and the southern desert south of Wadi Rum to the Saudi Arabian border with the Gebel Um Adami Mountain (peak at 1.947 m). The butterfly fauna includes 55 species.

New records of species in the region

Papilionidae

Papilio demodocus ESPER, **[1798]** is expanding northwards along the west and central Arabian Peninsula and along the Nile River. TEN HAGEN observed this species from close distance in Egypt in Giza, Cairo in the morning on 27 April 2011, around 9 am, in a private garden at the tourist parking for the Pyramids. The specimen was crossing the parking lot and settled down, sipping nectar (internet correspondence with the first author).

Almost simultaneously and on the same citrus host-plants, *P. demoleus* LINNAEUS, 1758 expanded westward, not only in Syria and Turkey at the northern Levant, but also from the Gulf states to central Saudi Arabia where it will eventually meet *P. demodocus* Esp. in central and western Arabia, as well as further to the north Red Sea Region.

Pieridae

Calopieris eulimene, (KLUG, 1829): This beautiful species has expanded northwards on both sides of the Red Sea. . It was first recorded in the northern Red Sea Region in May, 2001 where it was observed on Gebel Dafdaf (southern Gebel el-Lawz, northwestern Hejaz) between 1.500-2.000 m. This record marks its northern distribution limit and is a new species to Hejaz. In Egypt, it had never been recorded, including by this author (BENJAMINI) until its discovery by AHMED EL- GABBAS, a ranger in the Gebel

Elba protected area, on its unique Capparis decidua host plant (EL-GABBAS & GILBERT, 2016; GILBERT pers. comm. to BENJAMINI).

Colotis phisadia vagus D'ABRERA, 1980: Recorded from Gebel Hamajah, eastern Egypt Red Sea costal mountain range, in February 2003, between 1.300-1.500 m, in its northern distribution limit. Larger and darker than the nominal common ssp., both use the same hostplant – *Salvadora persica* L. (Salvadoraceae).

Colotis liagore (KLUG, 1829): Following three historical records from southern Egypt (Gebel Elba) and eastern Sinai (BENYAMINI & JOHN, 2020) it appeared again on the east side of the Red Sea in September 2001 on Gebel el-Lawz, northwestern Hejaz between 1.400-1.900 m. This record marks its current northern distribution limit nowadays and is about 820 km northwest of LARSEN'S 1983 record at Buraiman, Jeddah.

Colotis ephyia (KLUG, 1829): Observed on Gebel el-Lawz northwestern Hejaz in September 2001 between 1.400-1.900 m. This rare species was not reported from western Arabia by PITTAWAY (1985) nor by HOFMAN & DIETZ (1984) between Jeddah and Abha. LARSEN reported only one record from "Qanuna Khalt, Asir" – but noted that this location was not traced (p. 463). Central Asir Province is about 1.300 km from northwest Hejaz. That is, unless it was overlooked and not properly identified by former researchers.

Colotis halimede halimede (KLUG, 1829)

A new species to northwest Hejaz, where it was observed in May 2001 on Gebel Dafdaf (S Gebel el-Lawz) between 800-1.400 m. This record marks its northern distribution limit and is about 820 km NW of LARSEN'S 1983 record at Buraiman, Jeddah.

Colotis pleione pleione (KLUG, 1829): Observed in June 2001 on Gebel Dafdaf NW Hejaz, between 1.500-2.000 m. This is about 820 km NW expansion from LARSEN'S 1983 record at Buraiman, Jeddah, being the first record for northern Hejaz and the northern known distribution limit of this species.

Colotis (aurora) evarne (KLUG, 1829): A new species to Egypt, recorded from Gebel Hamajah 1.300-1.500 m, Feb. 2003, in the eastern Egypt Red Sea costal mountain range. This record marks its northern distribution limit.

Colotis protomedia (KLUG, 1829): Recorded from Gebel Shayib el Banat & Gebel Umm SW Hurghada, June 1999, between 1.200-2.000 m. This is a 550 km north-westwards expansion along eastern Egypt Red Sea costal mountain. range from its former recorded biotopes at the Hala'ib triangle were it was recorded in January and June, 400-2.000 m (GILBERT & ZALAT, 2007). This record marks its northern distribution limit and is new to the northern Red Sea Region.

Nymphalidae

Danaus c. chrysippus f. dorippus (KLUG, 1845): A very rare form to the east Mediterranean. It was collected in Binyamina in central Israel on May 31, 2019 following a rare Jet Stream that arrived from ~ Chad in the east Sub-Saharan Sahel belt (BENYAMINI & SHARON, 2019).

Charaxes hansali hansali C. & R. Felder, [1867]:

Ch. h. yemeni TURLIN, 1998: This is a "weakly described" subspecies according to – STEVE COLLINS (pers. comm. to BENYAMINI). *Ch. h. arabica* RILEY, 1931

While *Ch. h. hansali* C. & R. FELDER is confined to southeast Egypt in Gebel Elba, where it was recoded in March-April (GILBERT & ZALAT, 2007), *Ch. h. arabica* **RILEY** was recorded from Dhofar & Oman (LARSEN, 1983) and *Ch. h. yemeni* TURLIN was described from Yemen. On April 2001 it was discovered 1.300 km to the north in Gebel el-Lawz, NW Hejaz between 2.000-2.500m. This new species to Hejaz marks its northern distribution limit for the north Red Sea Region.

Junonia hierta crebrene TRIMAN, **1870**: Single specimens were recorded occasionally in the east Mediterranean, sometimes establishing temporary populations in gardens of coastal hotel-villages in east Sinai (RUDI VEROVNIK, pers. comm. to BENYAMINI). However in the summer of 2018 this species established a summer-autumn population along the Yarkon River (Tel Aviv) but perished when winter temperatures dropped (MISH'AN, 2018). This species appeared in 2019 in Kibbutz Yotvata, here it survived the winter and specimens were also observed the following spring 2020. It is likely that *J. hierta* (FABRICIUS, 1798) will succeed to establish a permanent population in the southern Arava, Israel's part of the Rift Valley.

Junonia orithya here LANG, 1884: A rare migrant to the Levant (LARSEN, 1984; BOZANO, 1990 & BENYAMINI, 2017a), this species established a permanent colony in Neot Smadar in southern Israel at least since 2017, where it breeds on *Phyla nodiflora* (L.) Greene (Verbenaceae).

Hypolinnas m. misippus (LINNAEUS, **1764**): A very rare migrant to the east Mediterranean, it appeared suddenly on the 8 and 9 of Feb, 2019 in Eilat, Israel, the northern Red Sea Gulf of Aqaba (KFIR et al., 2019)), where several do were nectar feeding on flowers of *Zilla spinosa* (L.) Prantl. (Brassicaceae) (Cruciferae). They were outnumbered by hundreds of migrating *V. cardui* (L.) on the same bushes. Their appearance was closely related to the Red Sea strange trough that arrived at the northern Red Sea Region from Sub-Saharan, eastern Sahel, in the region of Chad - see Plate 1.

Chazara persephone persephone (HÜBNER, [1805]): A mysterious species found in most of the Levant countries, this species flys for very short periods in spring and autumn and is usually aestivating unnoticed. Not recorded until singletons were photographed (Cyprus) or collected (Israel) (BENYAMINI, 2019a). The first author of this study, who visited the Sinai Peninsula for 14 years never observed it (BENYAMINI, 1984). However MIKE JAMES collected a single specimen near Saint Catherine's Monastery, in the southern Sinai in 2001, in its southern distribution limit. This is a new species to Egypt (GILBERT & ZALAT, 2007).

Hipparchia tewfiki (WILTSHIRE, 1949: 1 °, 1 ° were observed on Gebel el-Lawz, Tabuk, northwest Hejaz in May 2001 between 1.400-1.900 m. This is a northwards expansion of about 1.350 km from its recorded biotope in A-Soudah, southwestern Saudi Arabia (LARSEN, 1983). It is the butterfly with the longest expansion northwards that is recorded in this article and a new record for Hejaz.

Lycaenidae

Anthene amarah turlini LIBERT, **2010**: This subspecies that is confined to the Arabian Peninsula east of the Red Sea (Rift Valley) is rare in northern Red Sea. However in October – November 2016 following rains and flooding of a deep Red Sea trough, *A. a. amarah* LIBERT appeared in Eilat (as usual for such circumstances) and even expanded along the Rift Valley in southern Arava ~ 15 km north until Be'er Ora.

Cacyreus marshalli BUTLER, 1898: This species was recorded for the first time in the Middle East in early November 2019 in Ein Kerem, Jerusalem, Israel (BENYAMINI, 2019; BENYAMINI & KURMAN, 2020), Only two months elapsed and a specimen was photographed near Alexandria's international airport, Egypt. DNA analysis of the Jerusalem *C. marshalli* BTL. revealed that it is not different from the southern European stock (WIEMERS, pers. comm. to BENYAMINI). *Chilades pandava* (HORSFIELD, [1829]): This species was first reported from Giza (Egypt) in September 2012 (FRIC et al., 2014). In May 2015, it appeared in Eilat, southern Israel (SHALMON & BENYAMINI, 2015) and in September 2019 appeared in Ashkelon, southern Israel on the Mediterranean coast (BENYAMINI et al., 2019). It seems that the cycad blue is permanent in Egypt and Israel and will possibly expand to neighbouring countries

Lycaena pseudophlaeas (LUCAS, 1866): This species was recorded from Gebel Shayib el Banat and Gebel Umm 1200-2000 m, southwestern Hurghada, and eastern Egypt Red Sea costal mountain range in April 1999. It marks its northern distribution limit in Africa and is a new species to the Egyptian fauna

Hesperiidae

Spialia spio (LINNAEUS, 1767): Recorded in Gebel Hamata and Gebel Abu Hamamid, eastern Egypt Red Sea costal mountain. range, in May 1999, between 1.000-1.900m. This record marks the species' northern distribution limit and is new to the Egyptian fauna.

Spialia mafa higginsi Evans, 1937: Recorded in Gebel Shayib el Banat and Gebel Umm SW of Hurghada, eastern Egypt Red Sea costal mountain range in June 1999, between 1200-2000 m. This record marks its northern distribution limit and is new to the Egyptian fauna.

Spialia diomus (HOPFFER, 1855): Recorded in Gebel Shayib el Banat and Gebel Umm SW of Hurghada, E. Egypt Red Sea costal mountain range in April 1999, between 1.200-2.000 m. This record marks its northern distribution limit and is new to the Egyptian fauna.

Afrogegenes hottentota hottentota (LATREILLE, 1823): Observed in Gebel Elba for the first time in Egypt, between 800-1.400 m, in May 1983. This record marks its northern distribution limit in Africa.

Pelopidas mathias (FABRICIUS, 1798): A new species to northwestern Hejaz, where it was observed in Gebel Dafdaf between 1.500-2.000 m in September 2001. This is about a 450 km northwest expansion from LARSEN'S 1983 record at Khaybar N Medinah and marks its northern distribution limit.

species	Egypt	Sinai	Israerl S.	S. Jordan	Saudi
			Negev &		Arabia NW.
			Arava		Hejaz
references	8, 11, 12, 17,	1, 6, 9, 11, 21,	6, 7, 9, 10, 11,	2, 3, 4, 5, 6, 9,	2, 11, 19, 22,
	20, 21, 27, 28,	28	12, 13, 14, 15,	11, 16, 18, 23,	25, 28, 33, 35,
	30, 35, 37, 38		24, 28, 31, 32,	26, 28, 29	36, 38, 39
			34,35		
Papilio machaon syriacus Verity, 1908			1	1	
Papilio saharae saharae Oberthür, 1879	1	1	1	1	1
Papilio demodocus demodocus Esper, 1799					?
Papilio demoleus demoleus Linnaeus, 1758					?
Pieris brassicae catoleuca Röber, 1896	1	1	1	1	
Pieris rapae leucosoma Schawerda, 1905	1	1	1	1	
Pontia daplidice daplidice (Linnaeus, 1758)	1	1	1	1	1
Pontia glauconome glauconome (Klug, 1829)	1	1	1	1	1
Anaphaeis aurota Fabricius, 1793	1	1	1	1	1
Euchloe melanochloros aegyptiaca Verity, 1911	1	1	1	1	1
Euchloe belemia belemia (Esper, 1800)	1		1	1	
Euchloe falloui falloui (Allard, 1867)	1	1	1	1	1
Elphinstonia charlonia charlonia (Donzel, 1842)	1	1	1	1	1
Zegris eupheme uarda Hemming, 1929		1	1	1	
Zegris eupheme larseni Pittaway, 1986				1	1
Calopieris eulimene (Klug, 1829)	1				1
Colotis fausta fausta (Olivier, 1804)	1	1	1	1	1
Colotis phisadia phisadia (Godart, 1819)	1	1	1	1	1
Colotis phisadia vagus d'Abrera, 1980	1				
Colotis chrysonome chrysonome (Klug, 1829)	1			1	1
Colotis liagore (Klug, 1829)	1	1			
Colotis ephyia (Klug, 1829)					1
Colotis halimede halimede (Klug, 1829)					1
Colotis pleione pleione (Klug, 1829)					1
Colotis (aurora) evarne (Klug, 1829)	1				
Colotis danae eupompe (Klug, 1829)	1				
Colotis protomedia (Klug, 1829)	1				
Catopsilia florella (Fabricius, 1775)	1	1	1	1	1
Colias croceus (Geoffroy, 1785)	1	1	1	1	1
Danaus chrysippus chrysippus (Linnaeus, 1758)	1	1	1	1	1
Danaus c. chrysippus f. dorippus (Klug, 1845)			1		
Charaxes hansali hansali C. & R. Felder, [1867]	1				
Chraaxes hansali yemeni Turlin, 1998					1
Vanessa atalanta atalanta (Linnaeus, 1758)	1	1	1	1	
Vanessa cardui (Linnaeus, 1758)	1	1	1	1	1
Junonia hierta crebrene Trimen, 1870	1	1	1	1	1

species	Egypt	Sinai	Israerl S.	S. Jordan	Saudi
			Negev &		Arabia NW.
Junonia orithva here Lang, 1884			1	1	1
Hypolimnas misippus misippus (Linnaeus, 1764)	1	1	1	1	1
Melitaea telona Fruhstorfer, 1908			1	1	
Melitaea svriaca Rebel, 1905		1	1	1	
Melitaea deserticola macromaculata Belter, 1934	1	1	1	1	1
Chazara persephone persephone (Hübner, [1805])		1		?	
Hipparchia pisidice Klug, 1832		1	1	1	1
Hipparchia tewfiki (Wiltshire, 1949)					1
Pseudochazara telephassa (Gever, [1827])			1	1	_
Satvrium jebelia (Nakamura, 1976)		1		?	?
Tomares ballus Fabricius, 1787	1			-	
Cigaritis acamas acamas (Klug. 1834)	1	1		1	?
Cigaritis myrmecophila myrmecophila Dumont 1922	1	1	1	1	. ?
Iolaus alaucus alaucus Butler [1886]	1	2	1	1	. 1
Deudoriz livia livia (Klug 1834)	1	. 1	1	1	1
Lycana phlanas timeus (Cromer [1777])	1	1	1	1	1
Lycaena pseudophlaeas (Lucas 1866)	1	1	1	1	
Lycaena thersamon ownhale (Klug 1824)	1	1	1	9	
Anthene amarah amarah (Guárin Mánavilla 1947)	1	9	1	4	
Anthene amarah turlini Libort 2010	1	()	1	1	
I ampidas hostious (Linnsons, 1767)	1	1	1	1	
Lampiaes boencus (Linnaeus, 1767)	1	1	1	1	1
Leptotes pirithous pirithous (Linnaeus, 1767)	1	1	1	1	1
Cacyreus marshalli Butler, [1898]	1		1		
Tarucus balkanicus balkanicus (Freyer, 1844)			1	1	
Tarucus rosaceus (Austaut, 1885)	1	1	1	1	1
Azanus jesous (Guérin-Méneville, 1849)	1	1	1	1	1
Azanus ubaldus (Stoll, [1782])	1	1	1	1	1
Freyeria trochylus trochylus (Freyer, 1845)	1	1	1	1	
Lachides galba galba (Lederer, 1855)		1	1	1	?
Chilades eleusis (Demaison, 1888)	1				
Chilades pandava (Horsfield, [1829])	1		1		
Plebejides philbyi (Graves, 1925)		1	1	1	?
Polyommatus icarus zelleri Verity, 1919	1	1	1		
Plebejidea loewii uranicola (Walker, 1870)	1	1	1	1	1
Pseudophilotes abencerragus nabataeus (Graves,	1		1	1	
Pseudophilotes sinaicus Nakamura, 1976		1			
Pseudophilotes jordanicus Benyamini, 2000				1	1
Iolana alfierii Wiltshire, 1948		1	1	1	1
Zizeeria karsandra (Moore, 1865)	1	1	1	1	1
Zizina otis otis (Fabricius, 1787)	1				
Brephidium exilis exilis (Boisduval, 1852)					?
Spialia doris doris (Walker, 1870)	1	1	1	1	1
Spialia doris amenophis (Reverdin, 1914)	1				
Spialia spio (Linnaeus, 1767)	1				
Spialia mafa higginsi Evans, 1937	1				
Spialia diomus diomus (Hopffer, 1855)	1				
Gomalia elma elma (Trimen, 1862)	1				
Gomalia elma levana Benyamini, 1990			1	1	1
Carcharodus alceae alceae (Esper, 1780)	1	1	1	1	
Carcharodus stauderi ambigua Verity, 1925		1	1	1	
Carcharodus stauderi ramses Reverdin, 1914	1				
Sarangesa phidyle (Walker, 1870)	1				
Gegenes nostrodamus (Fabricius, 1793)	1	1	1	1	1
Gegenes "pumilio" (Hoffmannsegg, 1804)			1		
Afrogegenes hottentota hottentota (Latreille, 1823)	1		-		?
Pelopidas thrax thrax (Hübner, 1821)	1	1	1	1	
Pelopidas mathias mathias (Fabricius, 1798)	-	-	-	-	1
Borbo borbonica zelleri Lederer, 1855	1				
Total num, of species: 86	63	48	56	55	43
Additional new spp. : 21 (32.3%)	9 (17%)	1 (2.1%)	5 (9.8%)	3 (5.7%)	8 (22.8%)

Weather synoptic systems are the "conveyors" of Afrotropical and Arabian Peninsula Butterflies to the north Red-Sea & eastern Mediterranean Regions

Four types of exceptional weather synoptic systems play a major role in the sudden appearance of Afrotropical butterflies in the eastern Mediterranean and northern Red-Sea Regions. Lacking appropriate host plants, most of them will not survive. However, in the long run, it will change the composition of the fauna, enlarging the Afrotropical element in favour of the Palaearctic.

1) North African hot synoptic depressions – these arrive to the eastern Mediterranean and northern Red Sea regions in early spring and summer. Moving westwards, it brings butterflies of North Africa i.e. *Colotis fausta* (OLIVIER, 1804) specimens that appear too early when their *Capparis* spp. are still dormant and leafless, scarcely it brings specimens of *Hypolinnas misippus* (LINNAEUS, 1764).

2) Cross African Jet Stream - this originates in central-west Africa and is advancing North-Eastwards at an altitude of ~12 kms over Sub-Saharan Sahel. When it arrives at the northern Red-Sea/eastern Mediterranean, it may descend and change to low level barometric depressions resulting in heavy rains and floods. In early February 2019, it carried thousands *Vanessa cardui* (L.) and several *Hypolimnas misippus* (LINNAEUS, 1764) to Eilat and southern Arava in Israel and Jordania (KFIR et al., 2019).

3) **Red Sea Trough** – this type of tropical storm that originates in Sudan, and has intensified in the last decade, is the most important synoptic system that contributes to most of the influx of millions of migrants to the northern Red Sea region. Its results are expressed in this article.

4) Northwestern Indian Ocean cyclones – water temperatures of world oceans are rising permanently, led by the warmer Indian Ocean, are believed to be the reason for devastating tropical storms, hurricanes in Central America and southern North America, as well as cyclones in the Indian Ocean. The sea surface temperature (sst) of the West Indian Ocean (WIO), has warmed up tremendously, reaching 28-30°C average SST values of the "warm pool" in the ocean center. In 2019 alone, nine cyclones in the WIO struck the shores of the southern Arabian Peninsula (Plate 1) with heavy rains of tens of centimeters per day. The southern big desert Rub al Khali was in bloom and became the source of a huge migration of *Vanessa cardui* (L.) heading north along the Red Sea to the eastern Mediterranean and southern Europe.

Summary: The North Red Sea region, an ecotone and crossroads of the Palaearctic and the Afrotropical regions, possibly express the impact of the world climate change more than other zoogeographical regions in the world. In this article, we presented a northbound species expansion by hundreds of kilometers from the Ethiopian highlands to southern Egypt and its Red Sea mountain chain. In the western Arabian Peninsula, a similar expansion northward is recorded from the Asir and Tihama in southwest Saudi Arabia and Yemen to northwestern Hejaz. Table 1 summarizes the total number of species in each country where 22 species (34.3%) were added to the whole north Red sea region, 10 species (18.5%) were added to the Egyptian butterfly fauna (GILBERT & ZALAT, 2007), 8 species (22.8%) were added to northwestern Hejaz (LARSEN, 1983; PITTAWAY, 1985), 5 species (9.8%) to southern Israel, and 3 (5.7%) were added to southern Jordan. In the Sinai Peninsula, only one species (2.1%) was added. These numbers will grow as the greenhouse effect proceeds, adding southern butterflies to the list of the southeast Mediterranean, southern Levant and actually to all north Red Sea countries. This paper establishes the 2020 butterfly fauna baseline (though not complete) of this region for future researchers.

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Addresses of the authors

DUBI BENYAMINI (corresponding author) President, the Israeli Lepidopterists' Society 4D MicroRobotics, 91 Levona Str. Beit Arye, 7194700, Israel E-mail: dubi_ben@netyision.net.il

Dr. GÜNTER MÜLLER Widmannstraße 10 D-85356 Freising Malaria Research and Training Center, Faculty of Medicine, Pharmacy and Odonto-Stomatology University of Sciences, Techniques and Technology of Bamako BP 1805 Bamako, Mali E-mail: guntercmuller@hotmail.com

North Red Sea new species

Plate 1



North Red Sea - Egypt, Sinai, Israel, Jordan & Hejaz (NW Saudi Arabia)



Jet stream over E Sahel - Satellite image



Typical Red Sea Trough synoptic chart - autumn



Modified from image of positive Indian Ocean dipole event (BOM Australia)



Ocean temperature analysis by MERCATOR. Image produced by SWE.





NW Indian Ocean cyclones - 2019

North Red Sea new species Papilionidae, Nymphalidae, Lycaenidae & Hesperiidae - Plate 2



Papilio demodocus Linnaeus, 1758



Charaxes hansali yemeni Turlin, 1998



Danaus c. chrysippus f. dorippus (Klug, 1845) Binyamina, C Israel, 31.5.2019, leg. Danny Sharon



Hipparchia tewfiki (Wiltshire, 1949)

ð



Cacyreus marshalli Butler, [1898]



Chilades pandava (Horsfield, [1829])



Spialia spio (Linnaeus, 1767)



Pelopidas mathias (Fabricius, 1798)



Spialia diomus (Hopffer, 1855)

Lycaena (phlaeas) pseudophlaeas

(Lucas, 1866)





ð

Spialia mafa higginsi (Trimen, 1870)

Afrogegenes hottentota (Latreille, 1823)



North Red Sea new species Pieridae - Plate 3



Zegris eupheme larseni Pittaway, 1985



Calopieris eulimene (Klug, 1829)



Colotis phisadia vagus d'Abrera, 1980



Colotis (aurora) evarne (Klug, 1829)



Colotis liagore (Klug, 1829)



Colotis halimede (Klug, 1829)



Colotis ephyia (Klug, 1829)



Colotis pleione (Klug, 1829)



Colotis protomedia (Klug, 1829)



Colotis danae eupompe (Fabricius, 1775)

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