Entomology

Contribution to the study of the Pyraustinae Meyrick, 1890 (Lepidoptera, Crambidae) on the Arabian Peninsula: a new species of *Psammotis* Hübner, 1825 from Saudi-Arabia and new distributional data on four described species

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Abstract

Taxonomic and faunistic results on six genera of the Pyraustinae (Lepidoptera, Crambidae) are presented on the basis of material collected in SW Saudi Arabia (Hejaz, Asir and Fayfa mountains) and in Dhofar, the south-western province of Oman. A new species of the genus *Psammotis* Hübner, 1825, *Psammotis rubrilinearis* sp. nov. is described. The adults, the male and female genitalia and the tympanal organs are described and figured. The new species is placed closed to *Psammotis pulveralis* (Hübner, 1796), *Psammotis roseus* Maes, 2014 and *Psammotis rubrivena* (Warren, 1892) on the basis of shared character states in the male and female genitalia. The differential character states in wing maculation and morphology are listed. The presence of the genus *Psammotis* Hübner, 1825 is reported as new to the entomofauna of the Arabian Peninsula. New distributional records are given for four described species of the subfamily. The presence of *Achyra nudalis* (Hübner, 1796) in Saudi-Arabia is re-confirmed. *Palepicorsia ustrinalis* (Christoph, 1877) and *Uresiphita gilvata* (Fabricius, 1794) are reported as new for Oman. *Pioneabathra olesialis* (Walker, 1859) is reported as new for Saudi-Arabia. The current taxonomic status of the Arabian populations of *Pioneabathra olesialis* (Walker, 1859) is reconfirmed by means of DNA-Barcoding. The male and female genitalia of *Achyra nudalis* (Hübner, 1796) and *Pioneabathra olesialis* (Walker, 1859) and the male genitalia of *Palepicorsia ustrinalis* (Christoph, 1877) are figured.

Keywords: pyraloidea, pyraustini, portentomorphini, new species, morphology distribution, DNA-barcoding

1. Introduction

The Pyraustinae comprise at present 1270 described species in 173 genera, thus forming the third most diverse subfamily in the Pyraloidea (Nuss *et al*., 2023) [1]. Mally *et al*. (2019) [2] and Matsui *et al*. (2022) [3] confirm the monophyletic status of the subfamily listing synapomorphic character states in the internal morphology.

The Pyraustinae have a world-wide distribution. For the Afrotropical zone 160 species have been known till date, an estimated portion of 15% of which have been known as endemic till date (De Prins and De Prins, 2023) [4]. The potential of the Pyraustinae for island endemism has been shown in Marion (1955, 1956) [5, 6], Marion and Viette (1956) [7], Viette (1960, 1978) [8, 9, 10]. Eight genera have been known till date as endemic to the African mainland (Maes, 2006, 2014) [11, 12, 13].

The Arabian Peninsula however has till date been little explored for the Pyraustinae. Not more than 16 species in 11 genera have been reported to date. From the northern parts of the Arabian Peninsula, the UAE and the northern region of Oman eight species have recently been reported (Pelham-Clinton, 1977; Asselbergs, 2008; Monks *et al*., 2019) [14, 15, 16]. From the southern parts of the Arabian Peninsula 12 species have been reported till date, 75% of which have been reported exclusively on the basis of historical records dating to the end of the 19th century and to the beginning of the 20th century (Walsingham and Hampson, 1896; Rebel, 1907) [17, 18]. Recent records of the Pyraustinae from Dhofar and Yemen have been reported in Popescu-Gorj and Constantinescu (1977) [19], Hacker (2016) [20] and Seizmair (2021, 2022) [21, 22]. The endemic potential of the mountain systems along the Indian Ocean on the southern edge of the Arabian Peninsula and of the mountain systems in SW-Arabia and Yemen along the Red Sea (Asir, Fayfa, Hejaz) has been shown in Hacker (2016) [20] for the Noctuoidea Latreille, 1809. For the Pyraloidea however the endemic potential of the Arabian Peninsula has remained unexplored till date. This paper is intended as part of a series of studies on the diversity of the Pyraustinae on southern Arabian Peninsula based on material collected in in the southern Hejaz, the Asir and Fayfa mountains in Saudi-Arabia and in the coastal mountain chain (Jebel Al Qamar) in Dhofar. The present study covers five genera, three of which are assigned to the Pyraustini Meyrick, 1890, one is assigned to the Portentomorphini Amsel, 1956 and one is unassigned (*Incertae sedis*).

2. Materials and methods

2.1 Sampling

The material presented in this study is part of samples collected by the author in Saudi-Arabia in two expeditions (southern Hejaz, Asir, Fayfa) in April / May 2022 and in September 2022 and in three expeditions to Dhofar in 2018 - 2019.

The specimens were captured by night by means of two light traps, each equipped with four UV- Power-LEDs covering a

wave spectrum of 365 nm – 385 nm (LepiLED, Nichia, Tokushima, Japan; EntoLED, Starlight, Weissenburg, Germany). The trapping technique applied is described in Brehm (2017) [23].

2.2 Preparation, dissection, digital image processing

The adults were photographed after relaxation and subsequent preparation with a CANON EOS M6 Mark II under a MP-E-65mm zoom. For examining the genitalia, dissection, preparation and slide-mounting techniques were applied on the specimens on the basis of the protocol described in Robinson (1976) [24]. The preparation of the genitalia was done under a Motic stereomicroscope (SMZ-171). The slides were photographed with a ToupCam c-mount camera (ToupTek Inc., Zhejiang, China) under a resolution of 18 megapixels. Image stacking and background normalization were applied on the images by means of Adobe Photoshop PS, Version 24.0.0.

2.3 Morphological analyses

Analyses of wing pattern characters and morphological structures in the specimens were done on the images. Structural ratios were calculated on the images by means of the imaging software Toup View, Version 1.0 (ToupTek Inc., Zhejiang, China).

2.4 DNA-barcoding

The DNA-barcodes of selected specimens were extracted in the COI- segment of the mithochondrial DNA (mt-DNA). The barcoding technique applied is described in Ratnasingham. and Hebert (2007) [25]. Genetic distances on samples from the BOLD Database were calculated on the basis of the Kimura 2 Parameter Distance model. The sequencing and the calculation of the distance trees were done by the company AIM (Advanced Identification Methods), Leipzig, Germany.

2.5 Terminology and abbreviations

The descriptions of external and internal character states follow the terminology and systematics in Maes (1994) [26] and in Mally *et al*. (2019) [2]. Abbreviations: ZSM = Zoological State Collection Munich, Germany, N = length of a sample.

3. Results and discussion

3.1 Tribe Pyraustini Meyrick, 1890

3.1.1 *Psammotis rubrilinearis* sp. nov.

Zoobank ID

urn:lsid:zoobank.org:act:C6D4ADC0-54AC-4474-B73E-E00B7E7FC53A

Material

Holotype: ♀, Saudi-Arabia, Province Jazan, 5km NW Fayfa, 600m, 22-IX-2022, leg. M. Seizmair, coll. ZSM, slide no. 23GP001, Paratypes: 1 ♂**,** Saudi-Arabia, Province Jazan, Wadi Lajab, 1200 m, 26-IX-2022, leg et coll. M. Seizmair, slide no. 22GP077.

External characters (Fig 1)

Wingspan 11.9 mm - 12.8 mm. Forewing length: 5.6 mm - 6.5 mm.

Head: Frons and vertex white-scaled. Antenna filiform-ciliate, flagellum yellowish-brown, ciliae whitish-grey, basis with whitish-grey scales laterally. Proboscis reddish-ochreous. Labial and maxillary palpus upright, equal in length, length relative to the diameter of the eye 2.5, broadened at the basis, post-basally tapered and acuminate, dorsally brownish, ventrally darkish-grey, with the labial palpus white at the basis.

Thorax: Dorsum and venter greyish-white scaled. Legs yellowish-brown at the tibia, greyish-white at the femur.

Abdomen: Dorsum yellowish-brown, interspersed with greyish-white scales at the segments, with reddish scales laterally. Venter greyish-white interspersed with reddish scales.

Forewing: Costa straight. Apex down-turned, rounded. Termen and ventral border quasi straight. Upper side: Ground yellowish brown, with red antemedial, postmedial and anteterminal lines and a discocellular spot. Costa interspersed with darkish-red scales from the basis to the postmedial area. Antemedial line slightly undulated ranging from the costa to the ventral border. Postmedial line developing straight from the Sc onwards, near the M3 retracted below the distal and of the cell. Anteterminal line strongly broadened, developing from the R5, w-shaped, with the medial portion ranging to the termen, the curves basad-directed, forming an x-shaped structure with the postmedial line. Discocellular spot darkish-brown, small, orbiform. Fringe concolorous with the ground. Underside like upper side.

Hindwing: Costal border straight. Apex prominent, rounded. Tornus slightly edged. Upper side: Ground concolorous with the forewing ground. Postmedial line concolorous with the forewing postmedial line, developing from Rs and terminating at Cu1, strongly broadened, ranging to the termen. Presence of a red terminal line developing from Cu1 and terminating at A3. Presence pf a further red u-shaped line in the postmedial area with its two terminal points at A3 and its vertex near CuA1. Fringe concolorous with the forewing fringe. Underside like upper side.

Male genitalia (Fig 2B, 2D, 2E)

Uncus broadened, width relative to length 0.56, apically constricted and rounded with several simple chaetae ranging in length over one third of the uncus, scaphium present. Subscaphium present in the tuba analis. Transtilla arms triangular shaped, spatially widely separated. Valva basally strongly broadened, apically constricted and medially rounded, maximum width relative to the maximum length 0.36, costal border concave, basally projected, ventral border running parallel with the costal border, sella hook-shaped, ventrad-directed, strongly sclerotized and chaetose dorso-laterally, chaetae of the editum multifid and terminally flattened, with the basis of the editum ovate in shape and directed towards the aedeagus, sacculus basally constricted and rounded, post-basally broadened, distally tapered. Vinculum broadened. Saccus small, u-shaped, with a small protruding keel ventro-apically. Juxta broadened, bi-lobed, with the lobes small, acuminate. Phallus apodeme with two thorn-shaped extensions differing in length at the posterior end, vesica with two clusters of 4-5 cornuti variable in length. Coecum with slightly granulate areas, anteriorly rounded.

Female genitalia (Fig 2A)

Papilla analis broadened at the dorsal end, width of the dorsal end relative to the ventral end 1.7. Apophyses posteriores and apophyses anteriores equal in length, basally broadened.

Ostium membranous. Antrum strongly sclerotized laterally. Ductus bursae slender, widened at the transition to the corpus bursae, with a further dilatation in its posterior fourth. The anterior most dilatation is slightly granulated, the posterior most dilatation immediately below the antrum is strongly sclerotized, with an elongate, acuminate, anteriad-directed sclerite ventro-laterally. Corpus bursae orbiform, appendix bursae present. Rhomboid signum with two elongate thorn-shaped extensions, dorsal margin with a small concavity, ventral margin stout, flattened, length of the ventral margin relative to the dorsal margin 0.6, total length of the transversal axis relative to the length of the longitudinal axis 2.8. Presence of a secondary claviform signum near the basis of the appendix bursae. Appendix bursae sclerotized.

Tympanal organs (Fig 2C)

Venula secunda present, elongate, quasi straight. Bulla tympani strongly invaginated. Rami tympani ventrally strongly broadened, dorso-distally strongly narrowed, acuminate. Pons tympani rod-shaped, elongate, strongly sclerotized. Fornix tympany basally strongly broadened, sub-triangular-shaped. Tergo-sternal sclerite elongate, tapered, distally rounded.

Diagnosis

The new species is closely related in the male genitalia to the Palearctic *Psammotis pulveralis* (Hübner, 1796), the type species, furthermore to the Afrotropical *Psammotis roseus* Maes, 2014 and *Psammotis rubrivena* (Warren, 1892). These three species share the following character states in the male genitalia: the multifid chaetae in the editum, the shape and directedness of the editum basis – ovate and directed towards the aedeagus and the shape and directedness of the sella – hook-shaped and ventrad-directed.

In the male genitalia, the new species is differentiated from the three comparative species in the presence of two clusters of cornuti in the vesica and in the presence of two elongate, acuminate processes in the posterior end of the phallus. In the female genitalia the new species is differentiated from the each of the three species in the following character states: presence of sclerotized dilatations in the posterior fourth of the ductus bursae: present in the new species, absent in each of the three comparative species, in each of which the ductus bursae is constant in width except for the dilatation at the transition to the corpus bursae. Presence and position of a secondary signum near the base of the appendix bursae: present in *P. roseus*, in *P. rubrivena* and in the new species, absent in *P. pulveralis*. Furthermore, the new species is unmistakably differentiated from its congeners in the wing maculation, in particular in the w -shaped anteterminal line, the x-shaped structure formed by the anteterminal and postmedial lines in the forewing, the red hindwing postmedial line and the u-shaped red hindwing line developing from the A3 postmedially. The male and female genitalia of *P. roseus* and *P. rubrivena* are described and figured in Maes (2005) [27]. The male and female genitalia of *P. pulveralis* are figured in Slamka (2013) [28].

Bionomics (Fig 3)

The type habitat is characterized by dense vegetation in the herb and shrub layers. It is sporadically interspersed with rocks and located on the verge of a xeric montane woodland zone.

Distribution

The new species is to date only known from its type locality in South-Western Saudi Arabia (province Jazan, Fayfa Mountains).

Etymology

The epitheton refers to one of the external differential characters, the red line markings in the fore- and hindwing (lat. ruber / rubri = red).

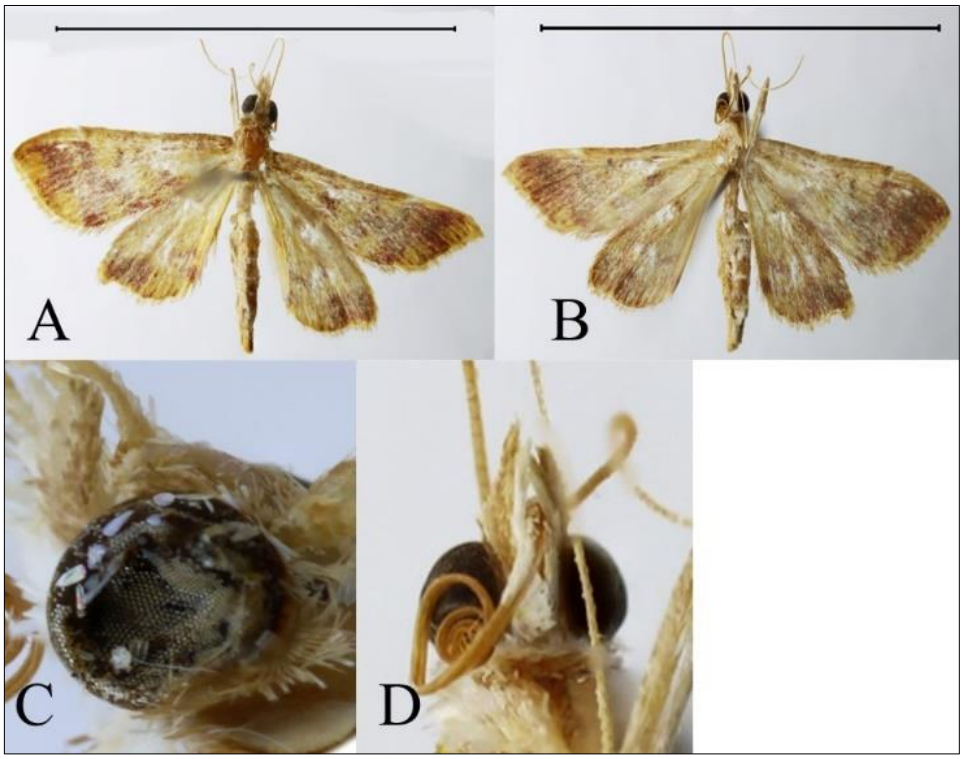

Fig 1: *Psammotis rubrilinealis* sp. nov., Holotype, ♀**,** slide no. 23GP001. A: upper side, B: underside, C: headprofile, lateral view, D: headprofile, ventral view. Scale bar = 10 mm.

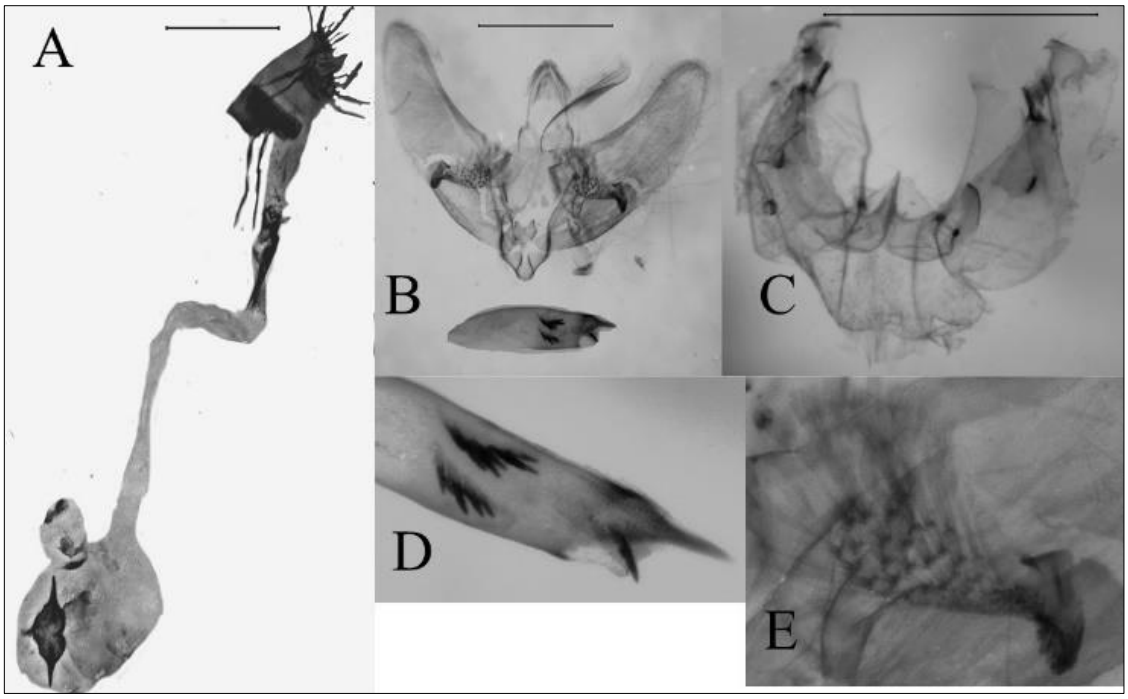

Fig 2: *Psammotis rubrilinearis* sp.nov., genitalia and tympanal organs. A: female genitalia, holotype**,** slide no. 23GP001, B, D, E: male genitalia, paratype, slide no. 22GP077 – B: ventral view, D: close-up - cornuti, posterior processes, E: close-up – editum, sella, C: tympanal organs, holotype**,** slide no. 23GP001. Scale bar = 1 mm.

Fig 3: Type habitat of *Psammotis rubrilinearis* sp.nov., Fayfa Mpountains, 5 km NW Fayfa, 600 m.

3.1.2 *Achyra nudalis* (Hübner, 1796)

Material

Saudi-Arabia, Provinve Jazan, 5 km NW Fayfa, 600 m, 1 ♂, slide no. 22GP061, 1 ♀, slide no. 22GP060.

Diagnosis (Fig. 4A, 5A, 5F)

Wingspan: 18.2 mm -18.6 mm. Forewing ground varying from brownish to pale yellowish, with presence of two claviform darkish brown spots, one below the basis of the cell, the other one at the distal end of the cell and a darkish brown postmedial line angled outward towards the termen. The strength of the postmedial line varies-it may be strongly interrupted and reduced to a series of spots or absent. Hind wing greyish-white, bare from maculation. Editum in the valva with oblong chaetae which are terminally flattened, Base of the editum stroke-shaped, hooked towards the ventral border, sclerotized ventro-laterally. Sella lobe shaped, ventrad-directed, running parallel to the basis of the valva, strongly sclerotized and denticulate ventro-laterally. Juxta bi-lobed, with the lobes medially sclerotized, with dilatations at the anterior and posterior ends. Saccus flattened. Ductus bursae in the female genitalia very long, coiled., with a strongly sclerotized dilatation at the anterior end, shortly before the antrum. Corpus bursae with a secondary signum of lanceolate shape.

Distribution

Palearctic: Southern Europe, North Africa (Slamka, 2013) [28]. Oriental: India (De Prins and De Prins, 2023) [4]. Afrotropical: East Africa (Kenya, Mozambique), South Africa, Namibia, Central Africa (Congo), West Africa (Niger), Cape Verde (De Prins and De Prins, 2023) [4]. For the Arabian Peninsula, recent records have been known from the northern region of Oman (Pelham-Clinton, 1977; De Prins and De Prins, 2023) [4, 14], exclusively historical records have been known till date from Yemen and Saudi-Arabia (Walsingham and Hampson, 1896; De Prins and De Prins, 2023) [4, 17]. Reconfirmed for Saudi-Arabia.

3.1.3 *Palepicorsia ustrinalis* (Christoph, 1877)

Material

Oman, Province Dhofar, Jebel Al Qamar, 20 km E Sarfait, 06-XI-2018, 2 ♂, slide no. GPPYR2119, 22GP020.

Diagnosis (Fig 4B, 5B, 5D)

Wingspan 18.2 mm -18.4 mm. Forewing ground brownish to pale yellowish, with the presence of two darkish-brown claviform spots above the middle of the cell and at the distal end of the cell respectively, of a darkish-brown postmedial line angled inward towards the basis and a darkish-brown

antemedial line. Hindwing yellowish pale with a darkish-brown postmedial line. The lines vary in strength, from strongly contrasted with the ground to absent. Uncus in the male genitalia broad, of constant width, apex stout. Valva basally strongly broadened, basal costa strongly concave, basal and post-basal ventral border forming a right angle, fibula s-shaped, posterior end acuminate, directed ventrad, anterior end rounded.

Distribution

Palearctic: Southern Europe (Slamka, 2013) [28]. Afrotropical: Western Sahara, Sudan (De Prins and De Prins, 2023) [4]. From the Arabian Peninsula the species has been known till date from Yemen exclusively on the basis of historical records (Walsingham and Hampson, 1896; De Prins and De Prins, 2023) [4, 17]. Recent records have been known from the UAE (Asselbergs, 2008) [15]. New to the entomofauna of Oman.

3.2 Tribe Portentomorphini Amsel, 1956

3.2.1 *Pioneabathra olesialis* (Walker, 1859)

Material

Saudi-Arabia, Province Jazan**,** Wadi Lajab, 1200 m**,** 27-IX-2022, 3♀, slide no. 22GP059, 22GP62, 22GP65, 5km NW Fayfa, 600 m, 22-IX-2022, 1♀, slide no. 22GP057. Oman, Province Dhofar, 4 km W Dalkuth, 4-XI-2021, 1♂, slide no. 22GP064.

Diagnosis (Fig 4C, 5C, 5G)

Wingspan 24.0 mm - 28.6 mm. Ground of forewing strong yellow. Presence of diffuse yellowish-pink antemedial and post-medial line markings and two cell spots located at the distal end and at the lower outer angle of the cell. The species varies with regard to the distinctiveness of the forewing line markings from distinct to completely absent. Male genitalia with distal uncus hook-shaped. Valva with three concave processes, with the anterior and posterior processes spatulate and chaetose, the medial process oblong, rod-shaped, medially directed, forming a right angle with the basis. Juxta bi-lobed, cordate. Vesica with a sclerotized patch of elongate teeth and several acuminate sclerites. Corpus bursae in the female genitalia with the signum consisting of an extensive granulated patch. Ductus bursae membranous, widened towards the corpus bursae. Antrum strongly sclerotized.

DNA-barcoding

Two specimens, slide no. 22GP064-065 were sequenced. The mean genetic distance of each of the two specimens to specimens of African mainland populations selected from the BOLD data base (N = 26) is 0.2%. The pairwise genetic distances in the comparative sample vary from 0.0 % to 0.5 %.

Distribution

Afrotropical: widespread in East, Central, West Africa and on the Malagasy islands (De Prins and De Prins, 2023) [4]. Oriental: India, Sri Lanka. Austral-Asian: Australia (De Prins and De Prins, 2023) [4]. From the Arabian Peninsula, historical records have been known to date from Socotra (Rebel, 1907) [18]. The species has been recently recorded from Oman, Dhofar (Hacker, 2016) [20]. New to the entomofauna of Saudi-Arabia.

3.3 Genus Uresiphita Hübner, 1852

3.3.1 *Uresiphita gilvata* (Fabricius, 1794)

Material

Saudi-Arabia, Province Mekka, Maysaan, 2100 m, 20-IV-2022, 31♂, Province Albaha, Blajurashi, 03-V-2022, 5♂, Province Jazan, 5km NW Fayfa, 22-IX-2022, 1♂. Oman, Province Dhofar, Jebel Al Qamar, 20km E Sarfayt, 24-XI-2019, 2♂, 03-XI-2018, 4♂, 24-XI-2019, 1♂, 2km W Sarfayt, Border Oman-Yemen, 19-I-2018, 2♂, 15-I-2016, 3♂, 4km W Dalkuth, 06-XI-2018, 2♂.

Diagnosis (Fig 4D)

Wingspan 25.0 mm – 32.8 mm. Forewing ground darkish brownish, with the medial area lighter in colour. Postmedial band broadened. Discocellular spot present, darkish brown, claviform. Hindwing ground yellowish. Marginal band present, darkish-brown.

Distribution

Palearctic – widespread in Central and Southern Europe and North Africa (Slamka, 2013) [28]. Oriental –Sri Lanka. Austral-Asian: Hawai, Rapa Island (De Prins and De Prins, 2023) [4]. Afrotropical – wide spread in East, Central and South Africa, on the Malagasy Islands (Seychellen) and on St. Helena (De Prins and De Prins, 2023) [4]. On the Arabian Peninsula the species has been known to date on the basis of historical records from Yemen and Saudi-Arabia (Butler, 1884; Walsingham and Hampson, 1896) [17, 29]. Re-confirmed for Saudi-Arabia. New for Oman.

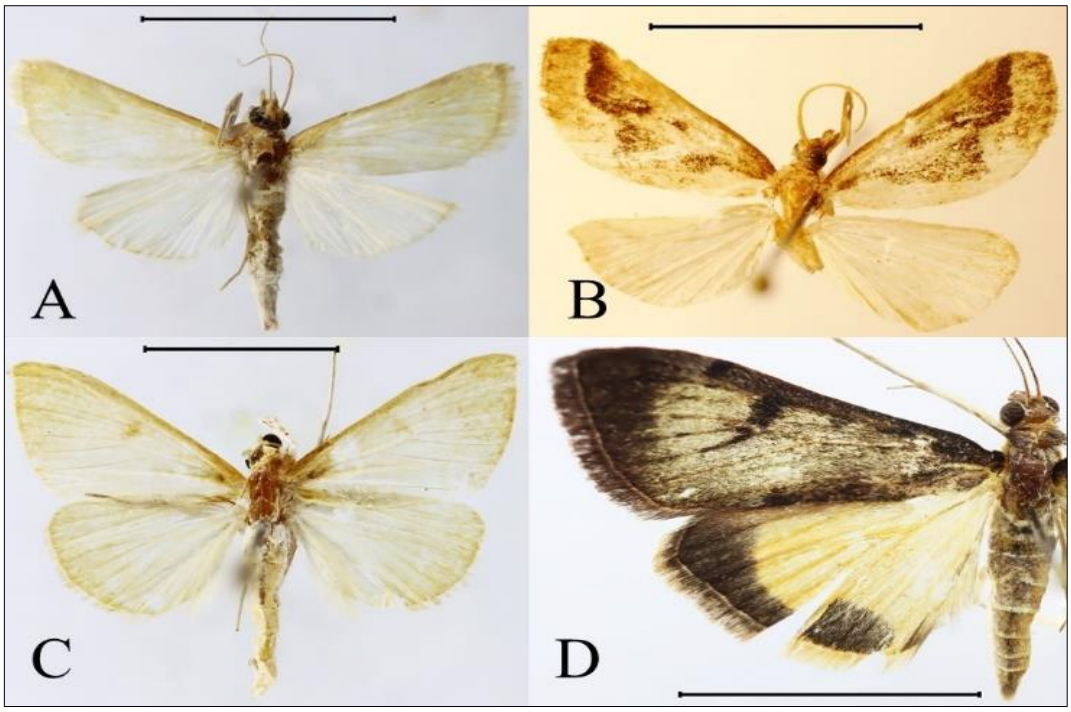

Fig 4: Adults. A: *A. nudalis*, ♂, slide no. 22GP061, B: *P. ustrinalis*, ♂, slide no. 22GP020, C: *P. olesialis*, ♀, 22GP059, D: *U. gilvata*, ♂, Saudi-Arabia, Province Mekka, Maysaan, 2100 m, 20-IV-2022. Scale bar = 10 mm.

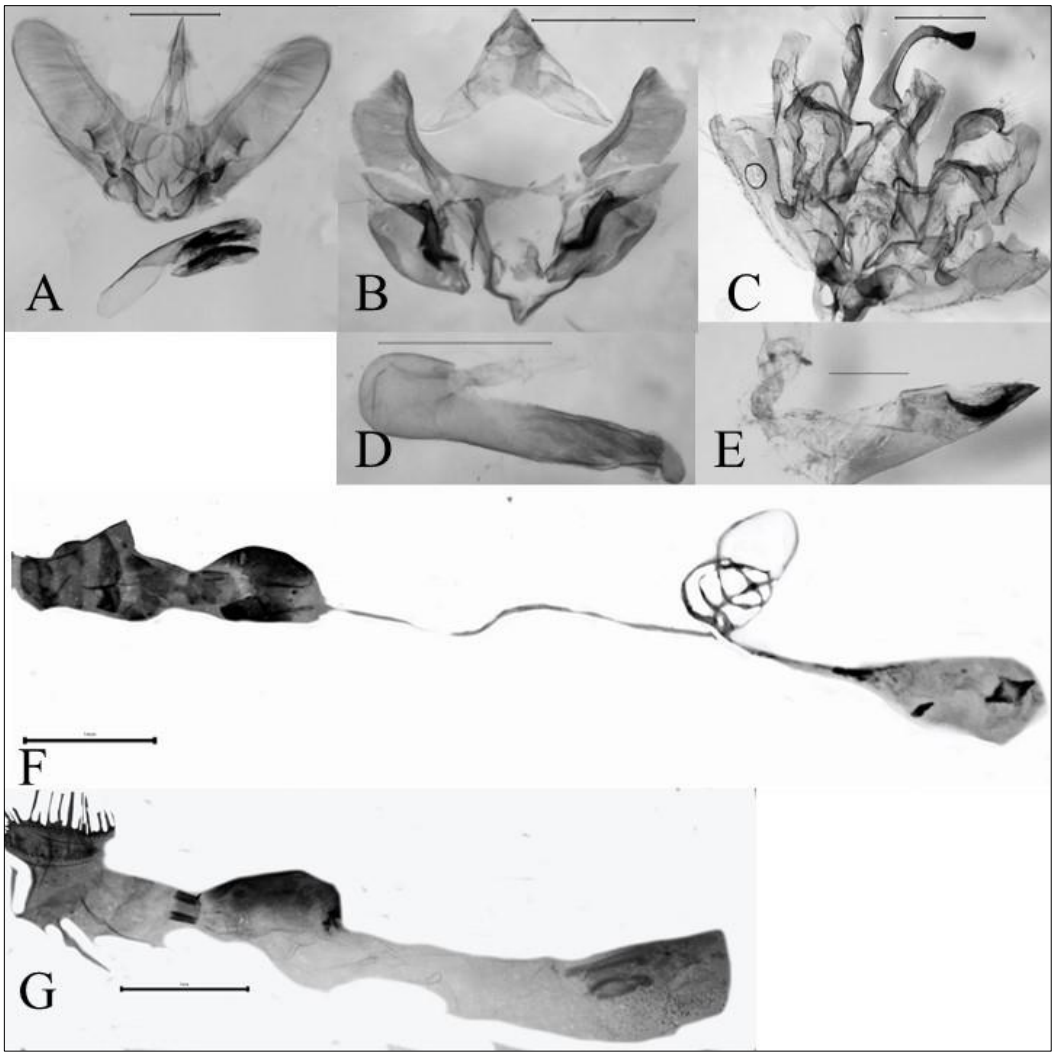

Fig 5: Genitalia. A: *A. nudalis*, male genitalia, ventral view, slide no. 22GP061, B, D: *P. ustrinalis*, male genitalia, slide no. 22GP020 – B: capsule, ventral view, D: phallus apodeme, C, E: *P. olesialis*, slide no. 22GP064 – C: capsule, ventral view, E: phallus apodeme, F: *A. nudalis*, female genitalia, slide no. 22GP060, G. P. olesialis, female genitalia, slide no. 22GP059. Scale bar = 1 mm.

4. Conclusion

In the present study the new species *Psammotis rubrilinearis* sp.nov. was described. The presence of the genus *Psammotis* Hübner, 1825 was reported as new to the entomofauna of the Arabian Peninsula. The new species is to date only known from its type locality in the Fayfa mountains of Saudi-Arabia. New distributional records were given for four described species: *A. nudalis* was reconfirmed for Saudi-Arabia. *P. olesialis* was reported as new for Saudi-Arabia. *P. ustrinalis* and *U. gilvata* were reported as new for Oman.

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Conflict of Interest Statement

The author declares that there are no conflicts of interest, neither of personal nor of material kind that could have influenced the results of this work.

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