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First records of the genus *Bradina* lederer, 1863 (Lepidoptera, Crambidae, Spilomelinae) from the Arabian peninsula with remarks on the taxonomy of the genus and description of a new species

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Abstract
New faunistic and taxonomic results on the genus *Bradina* Lederer, 1863 (Crambidae, Spilomelinae) are presented. A first approach to a sub-division of the Afrotropical and Oriental species of the genus is proposed. Seven species groups are identified based on wing pattern character states, namely the *Bradina admixtalis* (Walker, 1859)- group, the *Bradina adhaesalis* (Walker, 1859)- group, the *Bradina diagonalis* (Guinée, 1854)- group, the *Bradina sordidalis* (Dewitz, 1881) - group, the *Bradina cauvinalis* LeGrand, 1966- group, the *Bradina impressalis* Lederer 1863-group and the *Bradina remipes* Hampson, 1897- group. A determination key to the species groups and lists of Oriental and Afrotropical species attributed to each of the groups are given. The presence of the genus is reported for the first time for the Arabian Peninsula on the basis of records from Dhofar, the south-western province in the Sultanate of Oman. The specimens of the sample are attributed to the *Bradina admixtalis* (Walker, 1859) group. External and internal differential character states with regard to the closest congeners in this species group result in the description of the new species *Bradina triangularis* sp.nov. The male and female adults, the male and female genitalia and the tympanal organs are described and figured. The differential character states are listed. A determination key to the species of the *Bradina admixtalis* (Walker, 1859) group is given.

Keywords: Pyraloidea**,** STENIINI, taxonomy, morphology, Oman

Introduction
The genus *Bradina* Lederer, 1863 presently comprises 87 species, 54% of which are distributed in the Neotropical region (Nuss *et al*. 2021 [1]). The rest, which makes up 40 species, is distributed in the Afrotropical, Oriental and the Eastern Palearctic zones (Nuss *et al*. 2021 [1], De Prins and De Prins 2021 [2]). In the Eastern Palearctic zone, the western distribution ranges up to the Russian Far East (Nuss *et al*. 2021 [1], Caradja 1932 [3], Streltzow and Dubatolov 2009 [4]). In the Afrotropical zone, 11 species have been known to occur till date, with occurrences on the African Mainland and on the Malagasy and Mascarene islands (De Prins and De Prins 2021 [2]). On the African Mainland, occurrences of the genus have been reported from Eastern Africa (from Kenya to Zimbabwe), Southern Africa, Central Africa (Congo, Cameroon) and Western Africa (Nigeria, Liberia, Ghana) (De Prins & De Prins 2021 [2]). Three of the species occurring in the Afrotropical zone have wide distribution ranges also in the Oriental zone. The records of four species have till date been restricted to islands in the Mascarene and Malagasy regions (De Prins and De Prins 2021 [2]). No occurrence of the genus has been known till date on the Arabian Peninsula (De Prins and De Prins 2021 [2]). The genus is attributed to the tribe Steniini Guenée, 1854 in Mally *et al*. (2019) [5]. It is closest to the genera *Diathrausta* Lederer, 1863 and *Perisynthroca* Meyrick, 1894, with which it shares the presence of a signum with a toothed ridge in the ductus bursae wall. The male genitalia are characterized by an oblong valva with zero or one fibula developing from the basis to the apex. The genus is externally characterized by moths with long, triangular-shaped forewings, the forewing R2 stalked on the R3+4 stem, long antennae with very short ciliae, an oblong abdomen exceeding the hindwing tornus by roundabout 50%. Further recurrent character states in the genus are the presence of an anal tuft and the presence of a fovea in the upper angle of the forewing cell. An overall revision of the genus has not been done till date. A first partial revision of the Oriental species is given in Yamanaka (1984) [6]. In this paper, a first approach to a sub-division of the genus into species groups based on wing pattern character states is presented. The presence of the genus is reported as new to the entomofauna of the Arabian Peninsula on the basis of a sample collected in Dhofar, the south-western province in the Sultanate of Oman. The specimens of the sample differ significantly in external and genital-morphological character states from the closest congeners. These differential character states result in the description of the new species *Bradina triangularis* sp.nov.

Materials and Methods Sampling
The specimens were collected in two research expeditions to Dhofar in November 2019 and in November 2021. The specimens were captured in the day by means of an entomological hand net.

Macro-Preparation and Dissection
The adults were photographed with a SONY HX400V after relaxation and subsequent preparation. For examining the genitalia and tympanal organs, dissection, preparation and slide-mounting techniques were applied on the specimens on the basis of the protocol described in Robinson (1976) [7]. The preparation of the tympanal organs and 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. The images were optimized by means of the imaging software Adobe Photoshop PS, Version 21.0.2.

Morphological Analyses

Analyses of wing pattern characters and morphological structures in the specimens of the sample were done on the images. Structural ratios in external characters, genitalia and tympanal organs were calculated on the images by means of the imaging software ToupView, Version 1.0 (ToupTek Inc., Zhejiang, China). Mean values and standard deviations were calculated by means of the software MS Excel 2019. The specimens of the sample were compared with the types of the Afrotropical and Oriental species of the genus as listed in Nuss *et al*. (2021) [1] and in De Prins and De Prins (2021) [2] on the basis of type images and original descriptions. External character states of the types were analysed for the identification of species groups within the genus and the selection of the closest relatives to the species of the sample.

Terminology and Abbreviations

The denotations of the veins follow Shaffer & Munroe (2007) [8]. The descriptions of wing pattern characters, genitalia and tympanal organs follow the terminology in Maes (1995) [9]. Descriptions of characters and character states in the male and female genitalia were furthermore adopted from Mally *et al*. (2019) [5]. Abbreviations: ZSM = Zoological State Collection Munich, Germany, ± (SD) = Standard Deviation, n = cardinality of a sample.

Results and Discussion

Review of the Oriental and Afrotropical species

On the basis of wing pattern character states seven species groups in the genus are identified. The key to the species groups is given in Table 1.

Table 1: Key to the species groups in the genus *Bradina* Lderer, 1863

1	**Forewing postmedial line present**	**2**
-	Forewing postmedial line absent	5
2	Hindwing postmedial line present	3
-	Hindwing postmedial line absent	*B. cauvinalis* - group
3	Forewing antemedial line present	*B. sordidalis* - group
-	Forewing antemedial line absent	4
4	Forewing postmedial line angulated between R2 and R5	*B. admixtalis* - group
-	Forewing postmedial line slightly curved between M1 and M3	*B. adhaesalis* - group
-	Forewing postmedial line straight, bare from angulation	*B. diagonalis* - group
5	FW and HW bicolorous (with patches / bands distinct from the ground)	*B. impressalis* - group
-	FW and HW unicolorous	*B. remipes- group*

The attribution of the Oriental and Afrotropical species to each of the species groups is given in Table 2.

Table 2: Oriental and Afrotropical species of the genus attributed to each species group

B. admixtalis- group	*B. admixtalis* (Walker, 1859), *B. bicoloralis* Hampson, 1896, *B. eucentra* (Meyrick, 1937), *B. extenuatalis* (Walker, 1866), *B. geminalis* Caradja, 1927, *B. leopoldi* Ghesquière, 1942, *B. macaralis* (Walker, 1859), *B. mannusalis* (Walker, 1859), *B. modestalis* (Lederer, 1863)
B. adhaesalis- group	*B. adhaesalis* (Walker, 1859), B. *angustalis* Yamanaka, 1984, *B. atopalis* (Walker, 1858), *B. atralis* Pagenstecher, 1907, *B. aulacodialis* Strand, 1919, *B. aureolalis* Joannis, 1899, *B. consortialis* Caradja, 1927, *B. itysalis* Viette, 1957, *B. melanoperas* Hampson, 1896, *B. motitalis* (Fabricius 1787), *B. trigonalis* Yamanaka, 1984
B. diagonalis- group	*B. diagonalis* (Guinée, 1854), *B. erilitoides* Strand 1919, *B. flavalis* (Hampson, 1917), *B. intermedialis* Caradja, 1932, *B. megesalis* (Walker, 1859), *B. rectilinealis* South, 1901, *B. subpurpuresecens* (Warren, 1896), *B. translinealis* Hampson, 1896
B. sordidalis- group	*B. dentalis* Hampson, 1907, B. *planalis* (Swinhoe, 1894), B. pumilialis Hampson, 1907, *B. sordidalis* (Dewitz, 1881)
B. cauvinalis- group	*B. cauvinalis* LeGrand, 1966, *B. pionealis* Snellen, 1890
B. impressalis- group	*B. ceramica* Rothschild, 1915, *B. impressalis* Lederer, 1863, *B. plagalis* (Moore, 1867), *B. selectalis* Lederer, 1863
B. remipes - group	*B. opacusalis* Swinhoe, 1904, *B. remipes* Hampson, 1897

***Bradina triangularis* sp.nov.**

Zoobank ID: lsid:zoobank.org:pub:93664A8C-72BB-4DB3-82ED-520018ECBCE2

Material: Holotype: ♂, Oman, Dhofar, Ayun Athum Waterfalls, 06-XI-2021, slide no. 21GP051, leg. et prep. M, Seizmair, coll. ZSM. Paratypes: 6 ♂, same collection data as holotype, slide no. 21GP048 – 21GP050, 21GP052 – 21GP053, 1♂, same collection site as holotype, 21-XI-2019, slide no. 21GP011, 11♀, same collection data as holotype, slide no. 21GP054 – 21GP060, 2♀, same collection site as holotype, 21-XI-2019, leg., prep. et coll. M. Seizmair.

External characters (Fig 1 - 3): Wingspan of the holotype: 20.0 mm. Forewing length of the holotype: 12.2 mm. Wingspans of the paratypes: 15.0 mm - 19.57 mm, mean: 17,24 mm ± 0.3(SD), n=19. Forewing lengths of the paratypes: 7.8 mm – 11.3 mm, mean: 9,43 mm ± 0.22(SD), n=19. Head: Antenna filiform, flagellum yellowish-white, ciliae whitish-grey. Vertex, frons, tegula whitish-grey interspersed with yellowish scales. Proboscis yellowish-grey. Labial and maxillary palpus porrect, darkish-brown interspersed with greyish scales over all segments. Labial palpus broadened in segments 1 and 2, narrowed in segment 3 and rounded anteriorly. Maxillary palpus broadened in segments 1 and 2, tapered in segments 3 and 4, acuminate posteriorly. Ratio length of the labial palpus / diameter of the eye 0.4. Ratio length of the maxillary palpus / diameter of the eye 0.25. Ratio length of the maxillary palpus / length of the labial palpus 0.59. Ratio maximum width of the maxillary palpus / maximum width of the labial palpus 0.55. Thorax: dorsally greyish-white interspersed with darkish-yellowish scales, ventrally white. Legs greyish white, with the tibial spurs greyish-brown. Abdomen: Dorsally greyish-white from segments A1 to A5, yellowish from segments A6 – A8, ventrally constantly white. Anal tuft in the male laterally greyish-white, ventrally and dorsally yellowish. Forewing upper side: Fovea absent in the upper angle of the cell. Attachment point of the R2 to the R3+4 stem at the anterior end of the distal third of the wing. Costal border straight, apex and tornus acute, termen slightly curved at the M2. Mean ratio length of the forewing / maximum width of the forewing in the male 1.95 ± 0.3(SD), n=8, mean ratio length of the forewing / maximum width of the forewing in the female: 1,92 ± 0.06(SD), n= 13, thus no significant intersexual variation in the shape of the wings. Ground whitish grey, densely interspersed with darkish-grey to black scales from the basal to the subterminal area. Apex and sub-apical area with yellowish scales. Basal and antemedial lines absent. Discocellular spot darkish-brown, claviform. Subcostal stripe darkish-brown from the basis to the discocellular spot, darkish-yellowish from the discocellular spot to the apex. Postmedial line darkish-grey, weakly contrasted with the greyish scales, broadened at the onset between the costa and the R2, then tapered but distinct, uninterrupted, of constant strength, strongly angled at the R5, running parallel to the termen from the angle onwards. Fringe concolorous with the subterminal line. Forewing underside: like forewing upper side, with the postmedial line and the discocellular spot distinct and the density of the darkish-grey scaling reduced. Hindwing upper side: One frenulum present, oblong and strongly tapered, making up 17% of the maximum wing length. Attachment point of the M1 to the Sc+R1 – Rs- stem at the posterior end of the first proximal third of the wing. Ground concolorous with the forewing ground, densely interspersed with darkish-grey to black scales all over the wing. Discocellular spot of irregular shape, quasi claviform, concolorous with the forewing discocellular spot. Basal and antemedial lines absent. Postdiscal line concolorous with the forewing post discal line, slightly angled at the M2. Subterminal line and fringe concolorous with the forewing subterminal line and fringe. Hindwing underside: like hindwing upper side, with the discocellular spot and the postdiscal line distinct, the darkish-grey scaling reduced. Postdiscal and subterminal areas with yellowish scaling.

Male genitalia (Fig 4): Basal uncus arms broadened, sub-triangular shaped, postbasal uncus tapered, neck-shaped, straight, distal uncus bulbous-shaped, sclerotised and setose. Postbasal uncus equal in length with 90% of the basal uncus, ratio length of the postbasal uncus / length of the distal uncus 0.6. Tuba analis 1.6 times as long as the uncus, with a slight asymmetric dilatation medially, posterior end stout, with a deciduous, acuminate sclerite ranging from the base to the medial dilatation.

Tegumen of sub-rectangular shape, arms immediately below the basal uncus with extensive dilatations of ovoid shape. Dorso-lateral side of the tegumen with sub-triangular shaped anteriad-directed projections.

Valva oblong, ratio maximum length / maximum width 3.8, apex pointed. Basal costa with a distinct convex curvature, postbasal costa, distal costa and ventral border straight. One fibula present with a convex curvature parallel to the curvature of the basal costa. Costal, ventral borders and the interior of the valva with fields of long chaetae. Basal sacculus broadened, stout, postbasal and distal sacculus tapered and sclerotized. Transtilla arms with triangular-shaped posteriad-directed lateral projections at the basis of the valva, strongly broadened basally, acuminate and slightly sclerotized at the point of contact. Juxta rounded anteriorly, bi-lobed, with the lobes asymmetrical, of constant width, forming an obtuse angle and with lateral sclerotization. Saccus u-shaped, narrowed, with lateral sclerotization. Vinculum with elongate, posteriad-directed projections, which are lobe-shaped and rounded at the anterior end, tapered and acuminate posteriorly. Coremata pad sclerotized, setose and rounded at the posterior end, of sub-quadrangular-shape.

Phallus apodeme with two ventro-lateral sclerites developing from the anterior end of the caecum, the posterior ends with bifurcate dilatations. Ductusejaculatorius inserted at the anterior and of the caecum.

Female genitalia (Fig 5): Corpus bursae orbiform. Signum with an elongate spinose ridge, ratio transversal axis / longitudinal axis 3.4. The anterior side of the ridge is with downwards-directed lateral projections and with wide-spaced spinulae strongly varying in size and shape, with alternations of large and triangular-shaped, small and acuminate or rounded spinulae. The posterior side of the ridge is with a knob-shaped projection medially.

Ductus bursae widened at the transition to the posterior corpus bursae, from the transition to the corpus bursae to the antrum slender, of constant width. Anterior end of the ductus bursae near the ductus seminalis with a pair of distinct elongate, sub-rectangular shaped spinose sclerites with narrowly arranged spinulae at the anterior ridges. Transition to the ostium with three distinct sclerites, namely two lateral plate-shaped sclerites and one medial rod-shaped sclerite. Ostium bursae membranous, of sub-rectangular

shape. Apophyses anteriores angled and dilated at the end of the first posterior fifth, 1.8 times as long as the apophyses posteriores. Apophyses posteriores quasi straight, of constant width. Papillae anales oviform, ventral border equal in length with 75% of the dorsal border.

Tympanal organs (Fig 6): Bulla tympani strongly invaginated, with quasi-rectangular-shaped and sclerotized processes at the basis. Tympanum with an elongate, sclerotized dilatation. Fornix tympani dilated, with rod-shaped sclerites. Tergo-sternal sclerite slightly broadened and lobe-shaped at the base, tapered and acuminate anteriorly. Venula prima strongly sclerotized. Venula secunda absent. Zona glabra tympani with elongate transversal sclerites.

Differential diagnosis: The new species is attributed to the *B. admixtalis* – group. Within this group, the species closest to the new species in external characters are *B. admixtalis*, *B. macaralis* and *B. geminalis*. The differentiation of the new species and the comparative species from the rest of the *B. admixtalis*- group is given in Table 3.

Table 3: Key for the differentiation of the new species and its comparative species from the other species of the *B. admixtalis*- group

1	**Ground of forewing different from the ground of the hindwing**	***B. bicoloralis***
-	Ground of forewing concolorous with the ground of the hindwing	2
2	Ground gilded yellow	*B. extenuatalis*
-	Ground different from gilded yellow	3
3	Ground silky-white, with deciduous subapical black spots in the forewing	*B. modestalis*
-	Ground neither silky white nor gilded yellow, black subapical spots absent in the forewing	4
4	Termination point of the forewing postmedial line at the anal border displaced from the onset at the costal border towards the tornus	*B. leopoldi*
-	Onset at costal border and termination point at the anal border of the forewing postmedial line in a straight line, not displaced from each other.	5
5	Forewing subcostal stripe absent	*B. eucentra*
-	Forewing subcostal stripe present	6
6	Forewing postmedial line strongly interrupted, weakly contrasting with the ground	*B. mannusalis*
-	Forewing postmedial line non-interrupted, distinctly contrasting with the ground	{*B. triangularis sp.nov.*, *B. admixtalis*, *B. geminalis*, *B. macaralis*}

The external differential character states between the new species and its comparative species are given as follows: Presence of darkish-grey to blackish scales in the medial, antemedial and basal areas of the fore- and hindwing: present in the new species, absent in each of the comparative species. Ground, basic scaling: whitish-grey in the new species, reddish-brown to ochreous in *B. admixtalis*, darkish-brown in *B. macaralis*, pale yellowish, fuscous grey in *B. geminalis*. Position of the angle in the forewing postmedial line: at the R5 in the new species and in *B. macaralis* at the R3+4 in *B. admixtalis* and in *B. geminalis*. Presence of a basocellular spot in the forewing: absent in the new species, present in each of the comparative species. Scaling and range of the forewing subcostal stripe: ranging up to the apex in the new species, *B. admixtalis* and in *B. macaralis*, terminating in the postmedial area in *B. geminalis*, scaling darkish-brown to blackish in the basal area, then darkish-yellow from the antemedial area to the apex in the new species, constantly darkish-brown in *B. admixtalis*, *B. geminalis* and in *B. macaralis*. Scaling of the labial palpus: unicolorous - constantly darkish-brown in the new species, bicolorous- whitish-grey at the basal segment, darkish-brown at segments 2 and 3 in each of the comparative species. Scaling of the anal tuft: bicolorous – laterally greyish-white, medially yellowish in the new species, unicolorous in each of the comparative species.

The new species furthermore differs in the male genitalia from *B. admixtalis* and *B. geminalis* as follows. Presence of sclerotization in the tuba analis: present in the new species, absent in each of the comparative species. Shape of the transtilla: strongly broadened basally and triangular-shaped in the new species, slender and lobe-shaped in *B. admixtalis*, slender and acuminate in *B. geminalis*. Presence of projections on the dorso-lateral tegumen sides: present in the new species, absent in each of the two comparative species. Presence of sub-costal projections in the valva: absent in the new species and in *B. geminalis*, present in *B. admixtalis*. Shape of the juxta: bilobed with the lobes constantly broadened and in an obtuse angle in the new species, bilobed, with the lobes slender, tapered posteriorly, directed parallel to each other in *B. admixtalis*, uni-lobed, plate-shaped in *B. geminalis*. Presence of an elongate, pencil-shaped, posteriad-directed projection in the juxta-area: absent in the new species and in *B. geminalis*, present in *B. admixtalis*.

The new species differs in the female genitalia from *B. admixtalis* and *B. geminalis* as follows:

Overall shape of the signum: Ratio transversal axis / longitudinal axis > 3.0, ridge with elongate lateral projections in the new species. Bifurcate, ratio transversal axis / longitudinal axis < 2.5 in *B. admixtalis*. Ratio transversal axis / longitudinal axis < 2.5, ridge with short lateral projections in *B. geminalis*. Arrangement and size of the spinulae on the anterior side of the ridge: Widely spaced, varying in size, from large triangular-shaped spinulae to small acuminate or rounded spinulae in the new species, narrowly spaced, no variation in size, constantly small in *B. admixtalis* and in *B. geminalis*. Shape of the ductus bursae: dilated at the transition to the posterior corpus bursae, not narrowed at the antrum in the new species, not dilated at the transition to the posterior corpus bursae, narrowed at the antrum in *B. admixtalis*, dilated at the transition to the posterior corpus bursae, narrowed at the antrum in *B. geminalis*.

Presence of sclerites immediately anteriad from the ductus seminalis: two elongate spinose sclerites, one sclerite in each of the comparative species varying interspecifically in shape and size. Presence of sclerites at the transition to the

ostium: Two plate-shaped sclerites and one rod-shaped sclerite in the new species, zero sclerites in *B. admixtalis*, three rod-shaped sclerites in *B. geminalis*.
The male and female genitalia of *B. admixtalis* are described and figured in Guillermet (2009) [10]. The male and female genitalia of *B. geminalis* and *B. trigonalis* are described and figured in Yamanaka (1984) [6]. The male and female genitalia of *B. macaralis* are unknown.

Distribution: Known only from the type locality in Dhofar, the south-western province of the Sultanate of Oman.

Bionomics (Fig 7): The specimens were found in the day perching around near the ground on shadowy patches below trees, densely overgrown with grasses and diverse herbs and covered with dried foliage.

Etymology: The epitheton refers to one of the differential character states in the male genitalia, the triangular-shaped structure in the transtilla arms of the male genitalia.

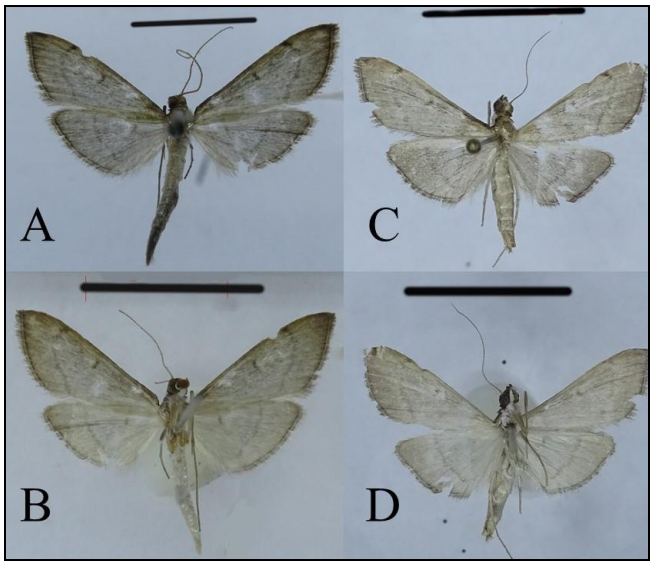

Fig 1: *Bradina triangularis* sp.nov., adults: A: Male holotype, upper side, B: Male holotype, underside, Oman, Dhofar, Ayun Athum Waterfalls, 06-XI-2021, leg. M. Seizmair, coll. ZSM, C: Female paratype, upper side, D: Female paratype, underside, same data as holotype, leg. et coll. M. Seizmair, scale-bars = 10 mm

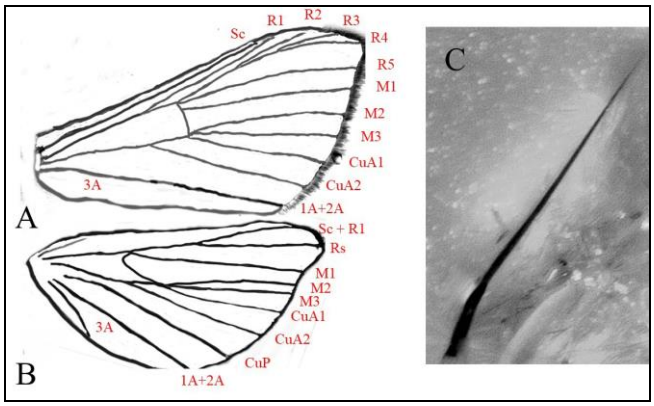

Fig 2: *Bradina triangularis* sp. nov., venation: A: Forewing, B. Hindwing, C: Close-Up, frenulum

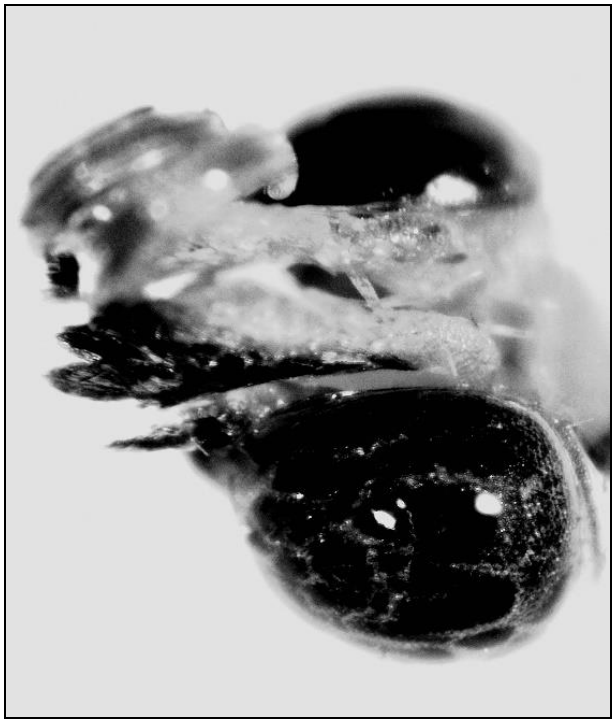

Fig 3: *Bradina triangularis* sp. nov, head profile

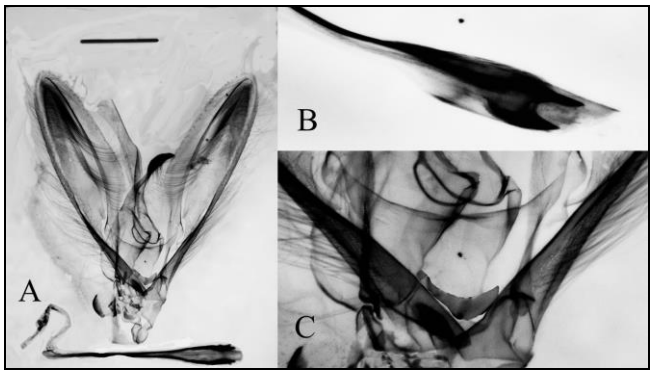

Fig 4: *Bradina triangularis* sp. nov., male genitalia, holotype, slide no. 21GP051: A: global view – genitalia capsule, phallus apodeme, B: Close-Up, phallus apodeme, lateral view, C: Close-Up, Transtilla, juxta, basal sacculus, scale-bar = 10 mm

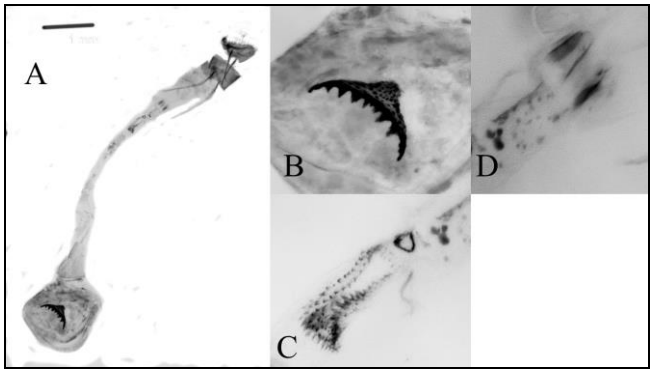

Fig 5: *Bradina triangularis* sp. nov., female genitalia, paratype, slide no. 21GP058: A: global view, genitalia capsule, B: Close-Up, signum, corpus bursae wall, C: Close-Up, sclerites at the ductus seminalis, D: Close-Up, sclerites at the transition to the ostium, scale-bar = 10 mm

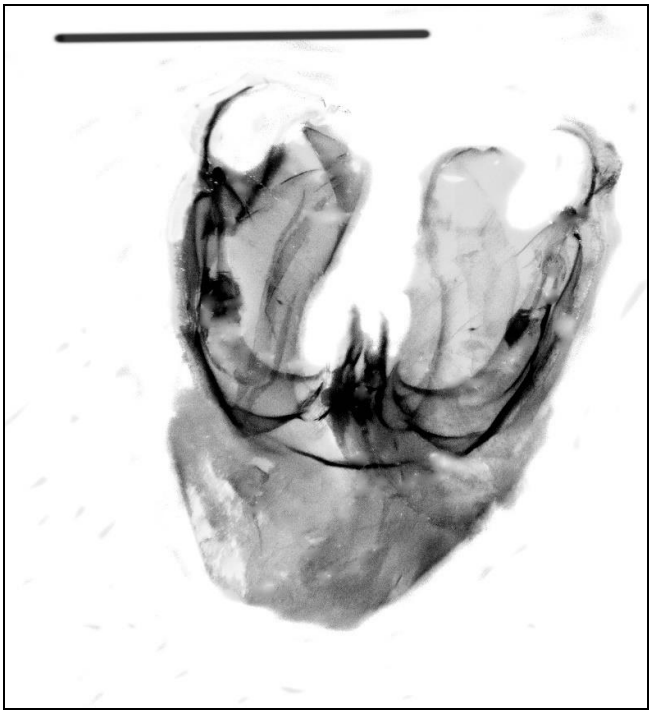

Fig 6: *Bradina triangularis* sp. nov., tympanal organs, paratype, slide no. 21GP060, scale-bar = 10 mm

Fig 7: Type habitat, Oman, Dhofar, Ayun Athum Waterfalls

Conclusion

A review of the Oriental and Afrotropical species if the genus *Bradina* Lederer, 1864, with a first approach to a subdivision of the genus into species groups is given. The presence of the genus is reported as new to the entomofauna of the Arabian Peninsula. The records are assigned to a species belonging to the *B. admixtalis*- group. External and internal differential character states with regard to the closest congeners in this species group result in the description of the new species *Bradina triangularis* sp.nov.

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