Description of androconia in the Palaearctic Asian *Pseudochazara baldiva* (Moore, 1865) butterfly species-group (Nymphalidae: Satyrinae) with designation of two lectotypes and reference to type and other material in the Natural History Museum, London

Andrew Wakeham-Dawson [1], Otakar Kudrna [2] & Roger L. H. Dennis [3]

[1] Mill Laine Farm, Offham, Lewes, East Sussex, BN7 3QB, UK;
e-mail: andrew@wakeham-dawson.orangehome.co.uk
[2] Naturmuseum Südtirol, Bindergasse 1, 39100 Bozen, Italy;
e-mail: Kudrna.MEB@t-online.de
[3] Institute for Environment, Sustainability and Regeneration, Room s122, Mellor Building, Staffordshire University, College Road, Stoke on Trent, ST4 2DE, UK;
e-mail: RLHDennis@aol.com

Abstract. Sakai's (1981) hypothesis (made in relation to material from Afghanistan) that the *Pseudochazara baldiva*-complex includes three species: *P. baldiva* (Moore, 1865), *P. lehana* (Moore, 1878), and *P. droshica* (Tytler, 1926) is tested by visual and statistical comparison of androconia scales from type and other specimens. The hypothesis is modified for a wider Central Asian study area to include *P. baldiva*, *P. droshica*, and *P. gilgitica* (Tytler, 1926) as the names that have priority to represent three species-groups, each of which exhibits distinctively shaped androconia. Evans' (1932a) misidentifications are resolved by designation of lectotypes for *Eumenis mniszechii balucha* Evans, 1932a and *Eumenis mniszechii balucha* f. *pallida* Evans, 1932a, and these two names are sunk in new synonymy as junior subjective synonyms of *P. gilgitica* and *P. baldiva* respectively. The findings of this study present a hypothesis of relationships for future testing against molecular and ecological data.

Introduction

The *Pseudochazara* de Lesse, 1951 butterflies of Afghanistan have been reviewed by Sakai (1981) as have those of Pamir, Turkmenistan, Uzbekistan, Tajikistan, Ladak and Kyrgyzstan (Tshikolovets 1997, 1998, 2000, 2003, 2005a, 2005b). Within this genus and endemic to Central Asia is a closely related group of mountain *Pseudochazara* taxa allied to *P. baldiva* (Moore, 1865). This is probably a natural complex of species artificially complicated by lepidopterists' enthusiasm for naming taxa on the basis of location and differences in wing colour and pattern. Wing colour, in particular, is an unreliable taxonomic character in this genus (Wakeham-Dawson & Dennis 2001). Building on the work of Gross (1978) and Sakai (1981), we are presenting a rigorous approach to taxon determination by looking at the androconia: male scent scales used in courtship of satyrine butterflies (Tinbergen 1972) and thus probably more closely linked to reproductive isolation between biological species than wing colour.

The present study is based on type and other specimens held in the Natural History Museum, London (BMNH). Androconia shape is compared visually and by statistical analysis of measurements made on the scales. We test Sakai's (1981) hypothesis (made in relation to material from Afghanistan) that the *P. baldiva*-complex includes three species: *P. baldiva*, *P. lehana*, and *P. droshica* and propose a modified hypothesis based on a wider range of material from Central Asia. Synonymies are suggested based on these

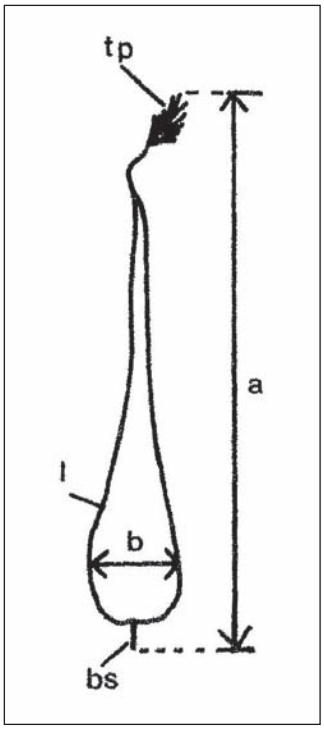

Fig. 1. Measurements of androconia from *Pseudochazara* type specimens held in the Natural History Museum, London. (a) androconium length (AL) from basal stalk (bs) to terminal points above apex (tp); (b) androconium breadth (AB) across the widest part of lamina (l). Terminology after Kudrna (1977).

results and a taxonomic/nomenclatural complication is resolved by designation of two lectotypes. The findings of this study present a hypothesis of relationships for future testing against molecular and ecological data.

Methods

Biometrics: androconia were prepared and measured using the methods described in Wakeham-Dawson (2006), Wakeham-Dawson & Kudrna (2000, 2005, 2006) and Wakeham-Dawson et al. (2003). In summary, androconia are removed from the forewing sex brands of male specimens and fixed on microscope slides. These slides are deposited in the BMNH and cross-referenced to specimens by authors' and museum reference numbers. Measurements of androconium length (AL) and breadth (AB) are made using an eyepiece graticule (Fig. 1) from between five and ten androconia per specimen (where possible). The shape of the androconia is expressed as a ratio *A* (length/breadth) and the androconia are drawn to scale. Where possible type or topotype material has been used and specimens determined by comparison to original taxonomic descriptions.

Statistical analysis: to test Sakai's (1981) three-group hypothesis measurements and ratios were subjected to *k*-means clustering (Legendre & Legendre 1998). The analysis was 'seeded' with three 'type' specimens as cluster centre points. These were specimens AWD628 to represent *P. baldiva* (a syntype), 631 for *P. droshica* (a syntype), and 618 for *P. lehana* (a topotype). The *k*-means clustering technique starts with *k* random clusters and then moves objects between clusters until (1) variability is minimized within clusters and (2) variability is maximized between clusters. The method is related to Analysis of Variance (ANOVA), and the success of the operation is determined from the *F* statistics associated with each variable (or dimension). It is a suitable technique for situations where a certain number of groups is suspected to exist in a dataset and allows testing *a priori* classifications by 'seeding' the analysis with 'type' specimens (see Wakeham-Dawson et al. 2004 for another example of the use of this technique). The *k*-means clustering was carried out on standardized variables (each value taken from the mean and divided by the standard deviation to give zero mean, unit variance) to ensure comparability among the three variables. As it was not possible to normalise variable AB, results from this technique were compared with those using Kruskal-Wallis ANOVA by ranks. These results were then compared with an ANOVA test on more limited material (n = 15) where all three variables were standardized (each normal) on wing lengths.

Material studied

Unless otherwise stated, all specimens are male. B. M. Rhopalocera Type Nos can be compared against Riley & Gabriel's (1924) catalogue. AWD = A. Wakeham-Dawson; OK = Otakar Kudrna. These names are written out in full on data labels, but are abbreviated in the following list.

1. *Pseudochazara baldiva* (Moore, 1865: 499, pl. 30, fig. 4). Originally named as '*Lasiommata baldiva*'. Sakai (1981) figures *P. baldiva* syntypes (male: pl. 24 figs 15–18; female: pl. 24 figs 19–20). Type locality: 'Spiti and Tibet'. Syntype in Type Collection drawer 1–58: '[**N. W. Himalaya]**, Upper Kunawur, Spiti, Lang 84', 'B. M. Type | No. Rh. 3724', 'Syntype | Lasiommata | baldiva Moore | det[ermined by] P. Ackery 1977', 'Coll. Moore 94–67', 'AWD | Androconia | preparation | 649'. Specimen 649 is accompanied by a female syntype ('B. M. Type | No. Rh. 3725') with similar data. Syntype in Main Collection drawer 3–22A: same data but 'AWD Androconia slide 628', 'BM(N.H.) | Rhopalocera | Slide No. | 30610'. Non type specimen in Main Collection drawer 3-22A: '**Skardo**, July, 2000 ft', 'Leech Coll. 1901–173', 'AWD Androconia slide 629', ' BM(N.H.) | Rhopalocera | Slide No. | 30608'. Specimen 629 is probably *P. gilgitica* (see below in Results).

2. *Pseudochazara lehana* (Moore, 1878: 227). Originally named as '*Hipparchia lehana*'. Syntype figured by Tshikolovets (2005a, pl. 23 fig.8). Type locality: 'Leh [34.10N, 77.35E], Kharbu [34.33N, 75.58E], 13000 ft, Ladakh'. Topotype in Main Collection drawer 3–23: '**Himalayas**, K[h]ardong [34.16N, 77.38E], 14000 ft, Aug. 1889', 'McArthur Coll. (Leech Coll. 1901–173)', 'AWD Androconia slide 618', 'BM(N.H.) | Rhopalocera | Slide No. | 30604'.

3. *Pseudochazara turkestana* (Grum-Grshimailo, 1893: 384). Originally named as '*Satyrus lehana turkestana*'. Type locality: 'Mts of Turkestan and Thian Schan (west)'. Topotype (syntype?) in Main Collection drawer 3–23: '**Boro Chozo**' <difficult to read: this could be Boro Khoro Mts, E. Turkestan, 44.20N, 83.00 E; further location data is illegible>, 1.vii.[18]89', 'Elwes Coll.', 'Coll. Gr[um]-Gr[shimailo]', 'AWD Androconia slide 620', 'BM(N.H.) | Rhopalocera | Slide No. | 30606'.

4. *Pseudochazara clarissima* (Seitz, 1908: 128). Originally named as '*Satyrus mniszechii clarissima*'. Seitz (1908, pl. 43 figs f & g) figures this taxon. Type locality: 'West China'. Topotype? (see Tshikolovets, 2005a: 105) in Main Collection drawer 3–23: '**N. Kashmir**, Hunza, 9450 ft, 21.viii.[19]13', 'No. 60', 'R. W. Hingston 1914-161', 'AWD Androconia slide 619', 'BM(N.H.) | Rhopalocera | Slide No. | 30605'.

5. *Pseudochazara esquilinus* (Fruhstorfer, 1911: 308). Originally named as '*Eumenis mniszechi* [sic] *esquilinus*'. Type locality: 'Alai'. 'Type' in Type Collection drawer 1–17: '**Alai Mont**[,] 1905[,] Korb', 'Fruhstorfer Coll. B.M. 1937-285', 'AWD | Androconia | preparation | 644'. Specimen 644 is accompanied by a female with the same data.

6. *Pseudochazara droshica* (Tytler, 1926: 256). Originally named as '*Eumenis lehana droshica*'. Sakai (1981) figures *P. droshica* syntypes (male: pl. 26 figs 5–6; female: pl. 26 figs 7–8). Type locality: 'Drosh and Shandur, Chitral'. Cotype in Type Collection drawer 1-58: '**Chitral**, Jhela Drosh', 'B. M. Type | No. Rh. 10762', 'Capt. S. W. Harris 98–182', 'AWD | Androconia | preparation | 654'. The distinctively torn female syntype illustrated by Sakai (1981) appears to be no longer present in drawer 1–58. Syntype in Main Collection drawer 3–22A: '**Chitral**, 20.vi.[19]10, [on] wall', 'Syntype (det. P. Ackery 1979)', 'H. C. Tytler Coll. Brit. Mus. 1941-92', 'AWD Androconia slide 631', 'BM (N.H.) | Rhopalocera | Slide No. | 30612'.

7. *Pseudochazara gilgitica* (Tytler, 1926: 256). Originally named as '*Eumenis lehana gilgitica*'. Type locality: 'Ghizer, Gilgit'. Syntype in Type Collection drawer 1–58: '**Chitral** | Shandur Pass | vii. 1901 | el[evation] 11000 ft | Coll. G. A. Leslie | & W. H. Evans | 1903–284', 'B. M. Type | No. Rh. |10764', 'AWD | Androconia | preparation | 653'. Specimen 653 is accompanied by a female syntype ('B. M. Type | No. Rh. 10765') with the following data: '**Chitral** | Shandur Pass | 11–14000 ft | 10.viii.[19]03 | A. R. C. Saunders | 1904–237'. Syntype in Main Collection drawer 3–22A: same data as specimen

653, but 'AWD Androconia slide 630a', 'BM(N.H.) | Rhopalocera | Slide No. | 30613'. Syntype in Main Collection drawer 3–22A: '**Gilgit**, Ghizer', '9. 23 [= ix.1923?]', 'H. C. Tytler Coll. Brit. Mus. 1941–92', 'AWD Androconia slide 630b', 'BM(N.H.) | Rhopalocera | Slide No. | 30614'.

8. *Pseudochazara balucha* (Evans, 1932a: 113). Originally named as '*Eumenis mniszechii balucha*'. Type locality: 'Urak, Baluchistan'. Evans' (1932b) inclusion of 'Ziarat, Kojak and Bogra' in the type locality is no longer relevant with the designation of a lectotype for this taxon. Lectotype in Type Collection drawer 1–58: '**Baluchistan** | Urak | 10.vi.[19]28', 'W. H. Evans | B.M. 1932–274', <dry genitalia preparation glued to card>, 'AWD | Syntype | det[ermined] 24.xi.2006', 'AWD & OK | Lectotype | [designated] 24.xi.2006' (see below in Results and Discussion), 'AWD | Androconia | preparation | 655'. Specimen 655 is accompanied by a female specimen with the following data: '**Baluchistan** | Ziarat | 17.vi.[19]28', 'W. H. Evans | B.M. 1932-274'. Three specimens (formerly topotypes) in Main Collection drawer 3–23: 1- '**Baluchistan** | Ziarat | 26.vi.1928', 'W. H. Evans | B.M. 1929–98', 'AWD | Androconia | preparation | 657'; 2- same data, but '21.vi.1928', 'AWD Androconia slide 624a', 'BM(N.H.) | Rhopalocera | Slide No. | 30619'; 3- same data, but '9.vii.1931', 'W. H. Evans | BM 1935–7', 'AWD Androconia slide 624b', 'BM(N.H.) | Rhopalocera | Slide No. | 30620'.

9. *Pseudochazara balucha* f. *pallida* (Evans, 1932a: 113). Originally named as '*Eumenis mniszechii balucha* f. *pallida*'. Type locality: 'Ziarat, Baluchistan'. Lectotype in Main Collection drawer 3–23: '**Baluchistan** | Ziarat | 17.vi.[19]28', 'W. H. Evans | BM 1932–274', <dry genitalia preparation glued to card>, 'Syntype male | Eumenis mniszechii | balucha f. pallida | Evans | det[ermined by] P. Ackery 1979', ' AWD & OK | Lectotype | [designated] 24.xi.2006' (see below in Results and Discussion), 'AWD | Androconia | slide 625 | 10.xii.2004', 'BM(N.H.) | Rhopalocera | Slide No. | 30621'. Specimen 625 has been misidentified and unnecessarily named by Evans. It is probably *P. baldiva* or *P. lehana* (see below in Results and Discussion). Sakai (1981) figures specimen 625 (pl. 28 figs 17–18) and a female syntype (pl. 28 figs 19–20). Topotype: same data, but '1.vi.1930', 'W. H. Evans | B.M. 1934–491', 'AWD | Androconia | preparation | 656'. Specimen 656, like specimen 625, is probably *P. baldiva* or *P. lehana* (see below in Results and Discussion). Mislabeled specimen: same data, but '30.vii.1930', 'W. H. Evans | B.M. 1934-491', 'AWD | [slide] 643 | 6.v.2005 | Androconia', 'BM (N.H.) | Rhopalocera | Slide No. | 30624'. Specimen 643 is most probably a worn and faded specimen of *P. balucha* (see below in Results and Discussion).

10. *Pseudochazara watsoni* Clench & Shoumatoff (1956: 148). Originally named as '*Pseudochazara mniszechii watsoni*'. Type locality: 'Kotal Pass, 3800 m, Afghanistan'. Paratype in Main Collection drawer 3–23: '**Afghanistan**, Kotal Pass, August [17, 19]17', 'Paratype [Series] No. 279, Carn. Mus. Ent. Avinoff Coll. CM Acc. 14608', '3rd Danish Exp. Cent. Asia 148, N. Harlov, #127', 'Brit. Mus. 1974–415', 'AWD Androconia slide 621', 'BM(N.H.) | Rhopalocera | Slide No. | 30607'.

11. *Pseudochazara atambegi* Wyatt & Omoto (1966: 161). Originally named as '*Satyrus* (*Pseudochazara*) *baldiva atambegi*'. Type locality: 'Bala Quran, Anjuman, Badachshan'. Topotype in Main Collection drawer 3–22A: '**Hindu Kush**, Bala Quran, 17.vii.1971, Y. Ishikawa', 'AWD Androconia slide 627', 'BM(N.H.) | Rhopalocera | Slide No. | 30609'.

12. *Pseudochazara wakhilkhani* Wyatt & Omoto (1966: 164). Originally named as '*Satyrus* (*Pseudochazara*) *watsoni wakhilkhani*'. Type locality: 'Bala Quran, Anjuman Valley, Badachshan'. Topotype in Main Collection drawer 3–23: '**Afghanistan**, NE Hindu Kush Mts, Bala-Quran, 3000–3400 m, 7–22.vii.1971, Anjuman V[alley], S. Sakai leg.', 'Brit. Mus. 1977-372', 'AWD Androconia slide 622', 'BM(N.H.) | Rhopalocera | Slide No. | 30617'. Non type specimen in Main Collection drawer 3–23: '**Afghanistan**, Kho-i-baba Mts, Mt Shah Fuladi, 3300 m, 8-12.viii.1974', 'Brit.-Mus. 1977–415', 'AWD Androconia slide 623', 'BM(N.H.) | Rhopalocera | Slide No. | 30618'.

Results

Measurements from the androconia are given in Table 1 (together with the nomenclatural type status of each specimen) and representatives of androconia are illustrated in Figs 2–5. These neomorphic (see Warren 1963) androconia can be grouped by visual

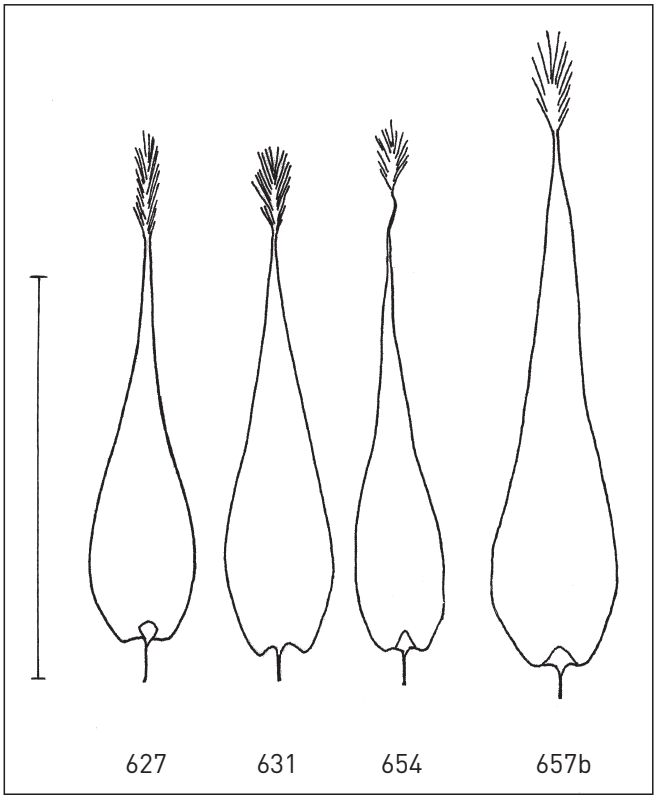

Fig. 2. Androconia (drawn to scale, with scale bar representing 0.25 mm) from specimens in Cluster 1: *P. atambegi* (AWD627), *P. droshica* (631 & 654), and aberrant *P. balucha* scale (657b).

comparison into three main shapes: (1) very bulbous at the base (*P. droshica* and *P. atambegi*; Fig. 2), (2) relatively tall and thin with lamina widest near base giving a triangular appearance (*P. gilgitica* and *P. balucha*; Fig. 3), and (3) relatively shorter and thinner with lamina widest further up from base than in (2) giving a cigar-shaped appearance (*P. baldiva*, *P. lehana*, etc.; Figs 4 & 5). Group (1) also includes aberrant scales from specimen 657, which have similar length to normal *P. balucha* scales, group (2) above, but are extremely bulbous at the base like *P. droshica* scales.

The *k*-means clustering analysis produced three significantly differentiated clusters based on significant differences in the measurements (Androconium length, AL: $F_{2,21} = 23.0$, $P < 0.001$; Androconium breadth, AB: $F_{2,21} = 46.5$, $P < 0.001$; Shape ratio, *A*: $F_{2,21} = 41.2$, $P < 0.001$). However, two of the 'type' specimens: 618 (*P. lehana*) and 628 (*P. baldiva*) are placed in the same cluster. This is not a surprising outcome when we consider our findings from visual comparison of androconia in Figs 2–5.

There are certainly three androconium shapes here as indicated by the three clusters, but from this analysis we have to reject Sakai's (1981) hypothesis that *P. lehana*, *P. droshica*, and *P. baldiva* are the three names that have nomenclatural priority to represent the clusters of type specimens before us. From our analysis we can see that *P. lehana* (Moore, 1878) is a junior subjective synonym of *P. baldiva* (Moore, 1865). Re-visiting our androconia drawings in Figs 2–5 indicates that *P. gilgitica* (Tytler, 1926) is the name that has priority to represent the cluster of relatively tall, thin androconia in our data set. So we reran the *k*-means analysis 'seeding' with 628 to represent *P. baldiva*, 631 for *P. droshica*, and 653 for *P. gilgitica* (all these specimens are syntypes).

This second analysis produces the same Euclidean distances between clusters and similar *F*-statistics (Androconium length, AL: $F_{2,21} = 21.8$, $P < 0.001$; Androconium breadth, AB: $F_{2,21} = 44.2$, $P < 0.001$; Shape ratio, *A*: $F_{2,21} = 40.2$, $P < 0.001$) as the first run and is represented in Fig. 6 as a non-metric multidimensional (NMMS) plot

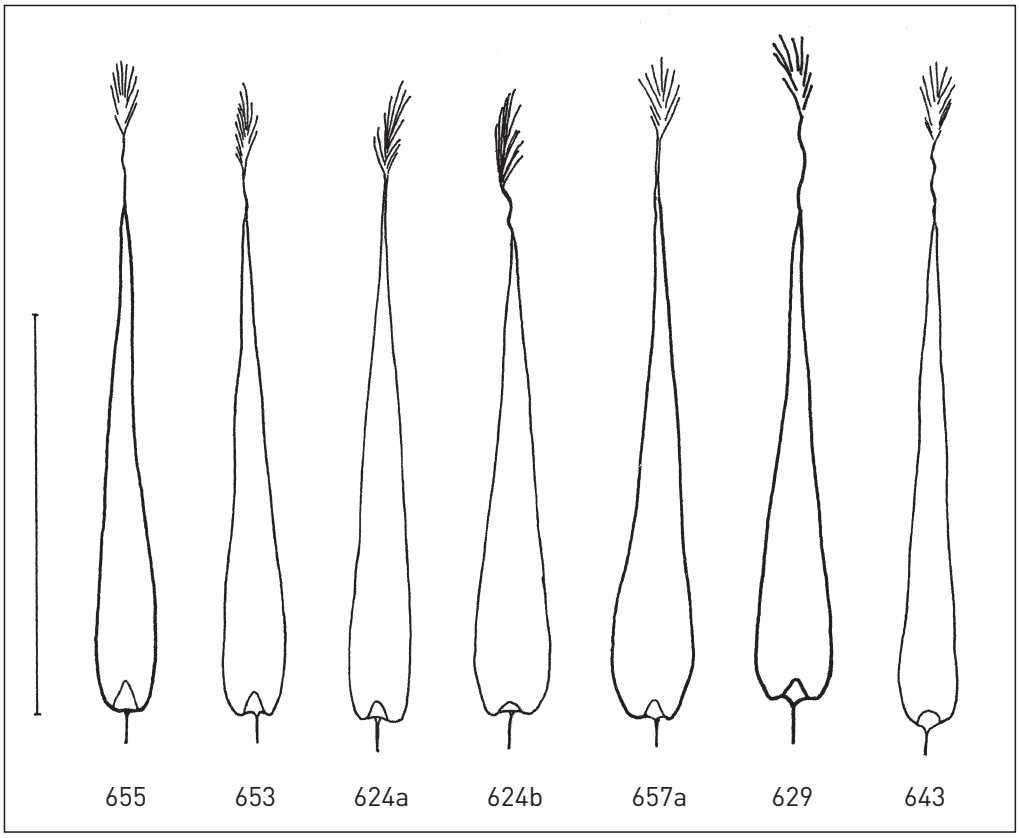

Fig. 3. Androconia (drawn to scale, with scale bar representing 0.25 mm) from specimens in Cluster 2: *P. balucha* (AWD655, 624a, 624b & 657a), a specimen (643) labeled as *P. balucha* f. *pallida*, which is probably *P. balucha*, and a specimen (629) labeled as *P. baldiva*, which is probably *P. gilgitica*. Specimen 653 is *P. gilgitica*.

of Euclidean distances. In Cluster 1 (four specimens represented by circles in Fig. 6): *P. droshica* (631 & 654) clusters with *P. atambegi* (627) and specimen 657b (aberrant scales from a *P. balucha* specimen) also clusters with this group. In Cluster 2 (seven specimens represented by triangles in Fig. 6): *P. gilgitica* (653) clusters with *P. balucha* (624a, 624b, 655 & 657a (normal scales)) and a specimen (643) labeled as *P. balucha* f. *pallida*. Specimen 629 (labeled as *P. baldiva*) also clusters with *P. gilgitica*, but 629 is not a type specimen and may therefore be *P. gilgitica*. In Cluster 3 (13 specimens represented by squares in Fig. 6): *P. baldiva* (628 & 649) clusters with *P. watsoni* (621), *P. wakhilkhani* (622 & 623), *P. esquilinus* (644), *P. clarissima* (619), *P. lehana* (618) and *P. turkestana* (620). Specimens 625 (syntype) and 656 that are labeled as *P. balucha* f. *pallida* in the BMNH collection also cluster with *P. baldiva*. Specimens 630a and 630b (syntypes) labeled as *P. gilgitica* in the BMNH collection also cluster with *P. baldiva*, but are at the edge of the cluster closest to the *P. gilgitica* cluster. The androconia from specimens 630a and 630b are not cigar-shaped and are widest relatively close to their base.

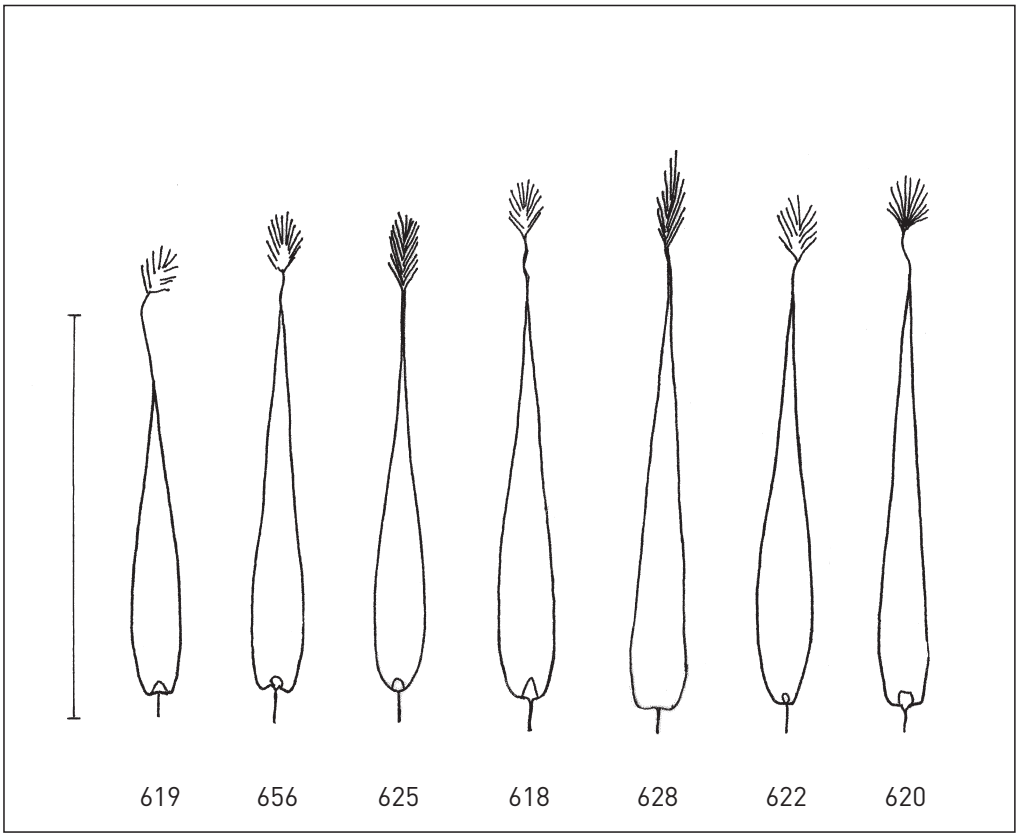

Fig. 4. Androconia (drawn to scale, with scale bar representing 0.25 mm) from specimens in Cluster 3: *P. clarissima* (AWD619), *P. balucha* f. *pallida* (656 & 625), *P. lehana* (618), *P. baldiva* (628), *P. wakhilkhani* (622), and *P. turkestana* (620).

Kruskal-Wallis ANOVA by ranks supported these contrasts ($H_{2,\ n\ =\ 24}$): AL = 13.2, $P = 0.0013$; AB = 16.1, $P = 0.0003$; $A = 9.7$, $P = 0.008$); all groups were separated using multiple comparisons: Clusters 1 and 2 by variables AB and *A*, Clusters 2 and 3 by variables AL and AB, and Clusters 1 and 3 by variable *A*. Using data standardized on wing lengths for a limited sample of 15 individuals (for which wing measurements were available), a one-way ANOVA confirmed inter-group (cluster) heterogeneity ($F_{6,20} = 16.0$, $P < 0.001$) despite small sample size, to which AB and *A* contributed to heterogeneity.

Discussion

The use of visual and quantitative comparison of specimens in the current study suggests that Sakai's (1981) nomenclature for the three androconia-shape groups based on material from Afghanistan should be replaced with the synonymy given below. This synonymy is based on material that includes more type specimens and covers a wider

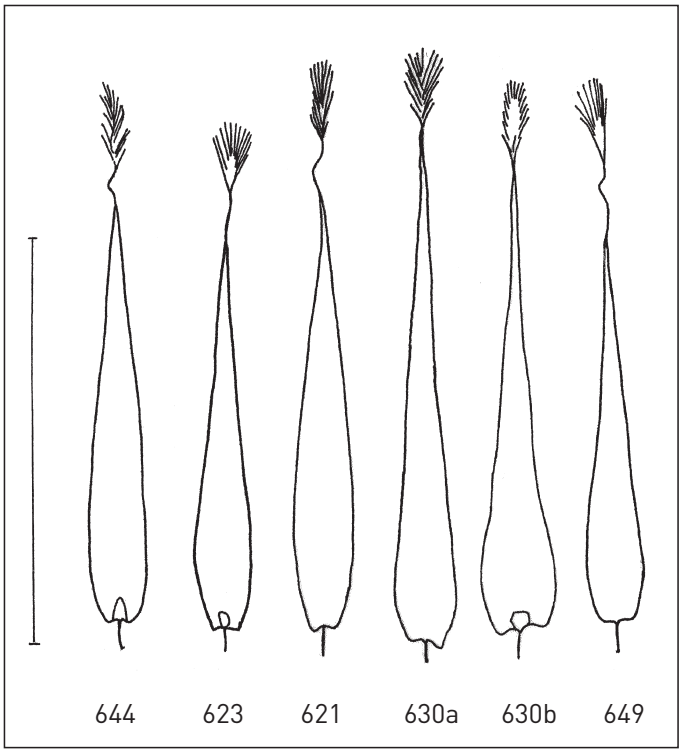

Fig. 5. Androconia (drawn to scale, with scale bar representing 0.25 mm) from specimens in Cluster 3: *P. esquilinus* (AWD 644), *P. wakhilkhani* (623), *P. watsoni* (621), *P. gilgitica* (630a & 630b), and *P. baldiva* (649). See text in relation to the placing of specimens 630a and 630b.

Central Asian study area. Additional probable synonymies of nominal taxa, for which material was not available to us in this study (but whose androconia have been reliably illustrated in other studies), are given in square brackets with references. These names have been used in so many combinations in the literature (e.g. see Gross 1978; Tuzov 1997; Tshikolovets 2005a, b) that, with two exceptions (see text below), we do not attempt to identify which of these are new synonymies.

***Pseudochazara baldiva* (Moore, 1865: 499)**

Hipparchia lehana Moore (1878: 227)
Satyrus lehana var. *turkestana* Grum-Grshimailo (1893: 384)
[*Satyrus lehana* var. *sagina* Heyne (1894: 542) (ref: Gross, 1978)]
[*Satyrus baldiva* var. *tarbagata* Staudinger (1901: 57) (ref: Wakeham-Dawson & Kudrna, 2005)]
Satyrus mniszechii clarissima Seitz (1908: 128)
Eumenis mniszechi [sic] *esquilinus* Fruhstorfer (1911: 308)
Eumenis mniszechii balucha f. *pallida* Evans (1932a: 113), syn. n.
Pseudochazara mniszechii watsoni Clench & Shoumatoff (1956: 148)
Satyrus (*Pseudochazara*) *watsoni wakhilkhani* Wyatt & Omoto (1966: 164)
[*Satyrus* (*Pseudochazara*) *watsoni dargaga* Wyatt & Omoto (1966: 165) (ref: Gross, 1978)]
[*Pseudochazara pseudobaldiva* Gross (1978: 62) (ref: Gross, 1978)]
[*Pseudochazara pakistana* Gross (1978: 63) (ref: Gross, 1978)]

***Pseudochazara droshica* (Tytler, 1926: 256)**

[*Pseudochazara porphyritica* Clench & Shoumatoff (1956: 150) (refs: Gross, 1978; Sakai, 1981)]

[*Satyrus* (*Pseudochazara*) *baldiva panjshira* Wyatt & Omoto (1966: 160) (ref: Gross, 1978)]

Satyrus (*Pseudochazara*) *baldiva atambegi* Wyatt & Omoto (1966: 161)

[*Satyrus* (*Pseudochazara*) *turkestana badachshana* Wyatt & Omoto (1966: 162) (ref: Sakai, 1981)]

[*Pseudochazara kopetdaghi* Dubatolov, 1989: 138 (ref: Dubatolov, 1989)]

***Pseudochazara gilgitica* (Tytler, 1926: 256)**

Eumenis mniszechii balucha Evans (1932a: 113), syn. n.

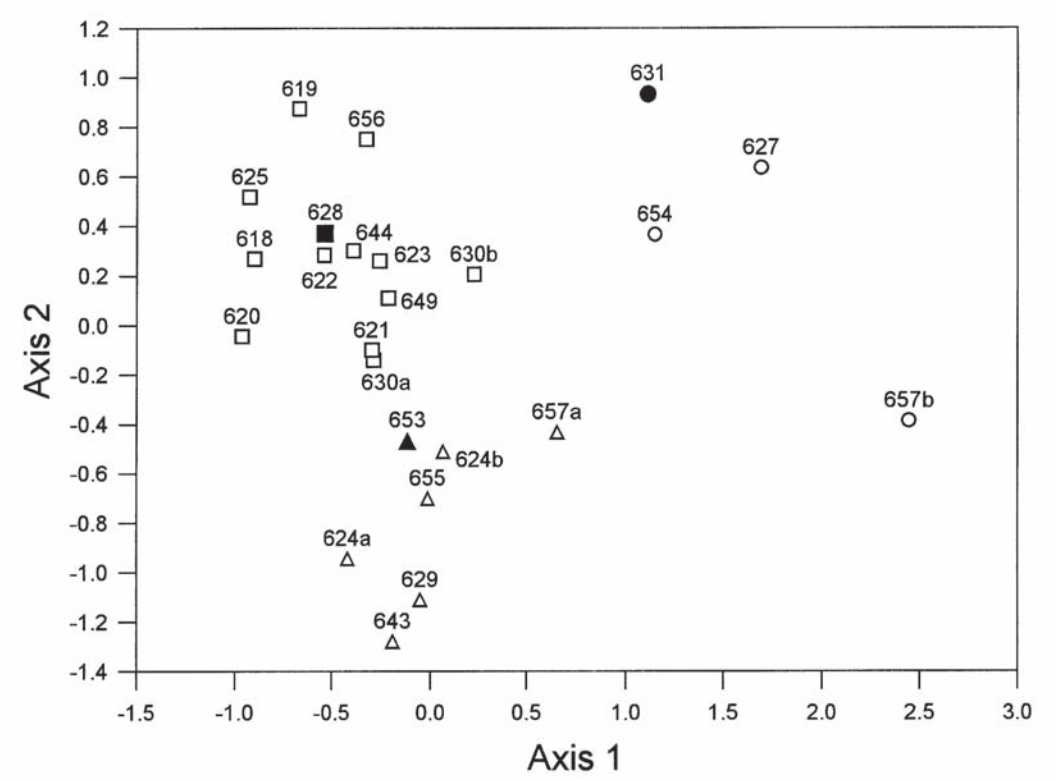

Fig. 6. A non-metric multidimensional (NMMS) plot of Euclidean distances between specimens (Alienation = 0.005 and Stress = 0.0003 indicating that the clusters are accurately represented); see text for explanation. Cluster 1 (circles): *P. droshica* (631 & 654), *P. atambegi* (627), and specimen 657b (aberrant scales from a *P. balucha* specimen). Cluster 2 (triangles): *P. gilgitica* (653), *P. balucha* (624a, 624b, 655 & 657a (normal scales)), specimen 643 labeled as *P. balucha* f. *pallida* and specimen 629 labeled as *P. baldiva*. Cluster 3 (squares): *P. baldiva* (628 & 649), *P. watsoni* (621), *P. wakhilkhani* (622 & 623), *P. esquilinus* (644), *P. clarissima* (619), *P. lehana* (618), *P. turkestana* (620), *P. balucha* f. *pallida* (625 & 656) and *P. gilgitica* (630a & 630b, see text in relation to the placing of these specimens). The three 'type' specimens used to seed the *k*-means analysis are indicated by filled symbols.

Tab. 1. Androconium length (AL) from basal stem to terminal points and androconium breadth (AB) across the widest point of the lamina (mm) (means ± sd), and ratio *A* (AL/AB; no units) (mean ± sd) that represents overall shape of androconia from 23 specimens among 12 nominal taxa of *Pseudochazara* butterflies. **Spec. No.** = Authors' numbers allocated to specimens and androconia slides. **BMNH No.** = BMNH Rhopalocera Slide Number; ***** = No. not yet allocated at time of publication. **N** = number of androconia measured. Status: **C** = cotype, **P** = paratype, **S** = syntype, **L** = lectotype, **T** = type, **TT** = topotype, **TT*** = topotype status removed by designation of lectotype, **NOT** = not type material, **+** = mislabeled in BMNH (this is probably *P. gilgitica*), **++** = mislabeled in BMNH (this is probably *P. balucha*).

Taxon	Status	Spec. No.	BMNH No.	AL	AB	*A*	N
P. atambegi	TT	AWD627	30609	0.344 ± 0.004	0.066 ± 0.002	5.19 ± 0.16	5
P. baldiva	NOT+	AWD629	30608	0.440 ± 0.011	0.041 ± 0.004	10.94 ± 0.79	5
P. baldiva	S	AWD628	30610	0.332 ± 0.012	0.032 ± 0.002	10.45 ± 0.75	10
P. baldiva	S	AWD649	*	0.356 ± 0.006	0.036 ± 0.002	9.85 ± 0.62	6
P. f. *pallida*	L	AWD625	30621	0.314 ± 0.010	0.028 ± 0.002	11.41 ± 0.69	10
P. f. *pallida*	NOT++	AWD643	30624	0.450 ± 0.015	0.039 ± 0.002	11.43 ± 0.31	6
P. f. *pallida*	TT	AWD656	*	0.311 ± 0.010	0.033 ± 0.002	9.35 ± 0.28	5
P. balucha	L	AWD655	*	0.414 ± 0.023	0.040 ± 0.002	10.28 ± 0.57	5
P. balucha	TT*	AWD657b	* (aberrant scales)	0.419 ± 0.005	0.082 ± 0.005	5.15 ± 0.31	3
P. balucha	TT*	AWD657a	* (normal scales)	0.406 ± 0.009	0.049 ± 0.002	8.34 ± 0.37	5
P. balucha	TT*	AWD624a	30619	0.423 ± 0.004	0.036 ± 0.002	11.70 ± 0.81	10
P. balucha	TT*	AWD624b	30620	0.402 ± 0.014	0.041 ± 0.003	9.89 ± 0.63	10
P. clarissima	TT?	AWD619	30605	0.296 ± 0.005	0.029 ± 0.002	10.21 ± 0.62	5
P. droshica	C	AWD654	*	0.358 ± 0.000	0.056 ± 0.000	6.36 ± 0.00	1
P. droshica	S	AWD631	30612	0.317 ± 0.011	0.056 ± 0.011	6.00 ± 1.48	10
P. esquilinus	T	AWD644	*	0.339 ± 0.015	0.034 ± 0.003	10.15 ± 1.19	5
P. gilgitica	S	AWD630a	30613	0.371 ± 0.011	0.036 ± 0.004	10.38 ± 0.99	10
P. gilgitica	S	AWD630b	30614	0.356 ± 0.009	0.042 ± 0.004	8.67 ± 1.04	10
P. gilgitica	S	AWD653	*	0.396 ± 0.011	0.039 ± 0.003	10.35 ± 0.90	5
P. lehana	TT	AWD618	30604	0.331 ± 0.011	0.029 ± 0.004	11.67 ± 1.81	5
P. turkestana	S?	AWD620	30606	0.351 ± 0.008	0.029 ± 0.001	12.20 ± 0.34	5
P. wakhilkhani	NOT	AWD623	30618	0.345 ± 0.008	0.035 ± 0.002	9.78 ± 0.52	5
P. wakhilkhani	TT	AWD622	30617	0.338 ± 0.013	0.032 ± 0.002	10.56 ± 0.74	10
P. watsoni	P	AWD621	30607	0.368 ± 0.008	0.036 ± 0.003	10.38 ± 0.98	10

Our comparison of androconia shows that specimen AWD625 (which has been identified as a syntype of *Eumenis mniszechii balucha* f. *pallida* Evans 1932 by P. R. Ackery) is clearly a different taxon from *Eumenis mniszechii balucha* and not just a pale form. This difference has been noted previously by Sakai (1981) and Wakeham-Dawson (2006). Evans (1932a: 113) describes his taxa as follows within a key of satyrid taxa that he includes in the genus *Eumenis*: 'WSF [Wet Season Form] band dark; on upf [upper-surface of fore-wing] decreasing to dorsum, lower ocellus always present and usually 2 white dots between the ocelli: unf [under-surface of fore-wing] discal line clear, submarginal line zigzag. DSF [Dry Season Form] band very pale, on upf of even width, lower ocellus rarely present and white dots absent; unf discal line clear, submarginal line sinuous. [*Eumenis*] *mniszechii balucha*, *nov*. (58-65). The Tawny Rockbrown. Baluchistan. NR. (DSF *pallida*, *nov*).'

Evans (1932b: 201-202) gives the following additional descriptions for his two taxa: '45. 'Eumenis mniszechii balucha', Evans and 'pallida', Evans. The Tawny Rockbrown. A large dark brown species with a broad tawny band across both wings. It flies from the Caucasus and Asia Minor to Central Asia, the N.-W. Frontier to Ladak and W. China. It is common from June to August at Urak, Ziarat, the Kojak and Bogra, and at Ziarat in May and June (perhaps elsewhere) there is to be met a very pale form. The ordinary local form differs from its allies in the following respects: on the forewing above the band decreases posteriorly, there is always a lower ocellus and usually two white dots between the ocelli: on the underside of the forewing the central line is clearly marked and the submarginal line is zigzag. The form *pallida*, probably an early brood, has the band very pale brown; forewing below the central line is distinct and the submarginal line is sinuous.' In addition (p. 197) he states: 'All the types will be placed in the British Museum'.

Evans had a mixed series of specimens before him and misidentified his 'f. *pallida*' specimens. Androconia shape indicates that specimen 625 (labeled as *balucha* f. *pallida*) is probably a member of our *P. baldiva* group. Specimen 656 (placed in the *balucha* f. *pallida* series) is probably also a member of our *P. baldiva* group. However, specimen 643 (also placed in the *balucha* f. *pallida* series) has *P. balucha*-shaped androconia (when compared with syntype specimen 655; see Fig. 3) and has been mis-placed as *P. balucha* f. *pallida* in the BMNH collection because it is worn and faded. In addition, the shape of the orange band on the forewings is like that of syntype *P. balucha* rather than syntype *P. balucha* f. *pallida*. Furthermore specimen 643 is labeled as having been captured in late July, while true *P. balucha* f. *pallida* specimens are labeled as having been captured in early to mid June.

To resolve any confusion of identity or nomenclature identified above, we hereby designate specimen AWD625 as Lectotype of *Eumenis mniszechii balucha* f. *pallida* Evans 1932a and synonymize this name with *Lasiommata baldiva* Moore 1865 (New Synonymy). In addition, we designate specimen AWD655 as Lectotype of *Eumenis mniszechii balucha* Evans 1932a and synonymize this name with *Eumenis lehana gilgitica* Tytler, 1926 (New Synonymy).

Our three-group synonymy is fairly bold and there is a danger that our nomenclature fails to acknowledge genetic variation between isolated populations of these butterflies.

The relationships between these taxa may be much more subtle with clines of variation and/or the effects of periodic isolation and recombination of mountain populations during ice ages. So the next stage in this research will be to test our hypothesis with additional material, molecular data and ecological field observations. Currently we do not know to what extent or even whether different androconia shape is associated with different pheromone production and how in turn this may be related to isolation between taxa. One of our *P. balucha* specimens (AWD657) merits special discussion in this respect. Two shapes of androconia are present on this specimen. The majority are typical *P. balucha* scales, but three scales on the microscope slide are shaped like large *P. droshica* scales. We are confident that these scales are not contamination from another specimen as colour, location and size all indicate that they belong to specimen 657. What has caused this 'mutation', and is it the same mechanism that has given rise to androconia shape differences between populations and taxa? Can we assume that both shapes of scale on this specimen produce the same chemicals? If so, this again raises the question as to whether shape differences correspond to chemical differences between taxa. Or is the presence of two scale types the result of hybridization between taxa?

Acknowledgements

We thank Geoff Martin, Jim Reynolds and Phil Ackery (Department of Entomology, The Natural History Museum, London at Wandsworth), Goulven Keineg (Entomology Library, Wandsworth) and Alison Harding (Entomology Library, Tring) for their assistance in this study. Comments by Yuri Nekrutenko, an anonymous referee, and the editors improved an earlier draft of this paper.

References

Clench, H. K. & N. Shoumatoff 1956. Lepidoptera Rhopalocera (Insecta) from Afghanistan. The 3rd Danish Expedition to Central Asia. – Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening **118**: 141–191.

Dubatolov, V. V. 1989. [New species of butterflies (Lepidoptera, Lycaenidae, Satyridae) from Middle Asia]. – Proceedings of the Zoological Institute, Leningrad **200**: 136–140.

Evans, W. H. 1932a. The Identification of Indian Butterflies. Second Edition Revised. – Bombay Natural History Society, Madras. 454 pp., 32 pls.

Evans, W. H. 1932b. The butterflies of Baluchistan. – Journal of the Bombay Natural History Society **36**(1): 196–209.

Fruhstorfer, H. 1911. Satyridae. Pp. 285–401. – *In*: Seitz, A. (ed.), Die Gross-Schmetterlinge der Erde, vol. 9. Die Indo-Australischen Tagfalter. – Alfred Kernen Verlag, Stuttgart.

Gross, F. J. 1978. Beitrag zur Systematik von *Pseudochazara*-Arten (Lep., Satyridae). – Atalanta, Wurzburg **9**: 41–103.

Grum-Grshimailo, G. E. 1893. Lepidoptera palaearctica nova. II. Horae Societatis – Entomologicae Rossicae **27**: 379–386.

Heyne, A. 1894. Pp. 529–576. – *In*: Rühl, F. & A. Heyne, Die palaearktischen Grossschmetterlinge und ihre Naturgeschichte. Vol. 1, Lief 11. – E. Heyne, Tagfalter. Leipzig.

Kudrna, O. 1977. A Revision of the Genus *Hipparchia* Fabricius. – Classey, Faringdon. 300 pp.

Legendre, P. & L. Legendre 1998. Numerical Ecology. Second Edition. – Elsevier, Oxford. xv, 853 pp.

Moore, F. 1865. List of diurnal Lepidoptera collected by Capt. A. M. Lang in the N. W. Himalayas. – Proceedings of the Zoological Society of London, **1865**: 486–509.

Moore, F. 1878. Descriptions of new species of Lepidoptera collected by the late Dr F. Stoliczka during the Indian-Government Mission to Yarkund in 1873. – Annals and Magazine of Natural History **(ser. 5) 1**: 227–237.

Riley, N. D. & A. G. Gabriel 1924. Catalogue of the Type Specimens of Lepidoptera Rhopalocera in the British Museum. – BMNH, London. 62 pp.

Sakai, S. 1981. [Butterflies of Afghanistan]. – Kodansha, Tokyo. 271 pp., 48 pls.

Seitz, A. 1908. 4. Familie: Satyridae. Pp. 79–153, pl. 43. – *In*: Die Grossschmetterlinge de Erde…, 1. Abteilung: Die Grossschmetterlinge des Palaearktischen Faunengebietes. 1. Band: Die Palaearktischen Tagfalter. – Fritz Lehmann Verlag, Stuttgart.

Tinbergen, N. 1972. The courtship of the grayling *Eumenis* (= *Satyrus*) *semele* (L.). Pp. 197–249. – *In*: Tinbergen, N. (ed.), The Animal in its World: explorations of an ethologist. 1, Field Studies 1932–1972. – Allen & Unwin, London.

Tshikolovets, V. V. 1997. The Butterflies of Pamir. – Slamka, Bratislava. 282 pp., 46 pls.

Tshikolovets, V. V. 1998. The Butterflies of Turkmenistan (Lepidoptera, Rhopalocera). – Tshikolovets, Brno-Kyiv. 237 pp., 34 pls.

Tshikolovets, V. V. 2000. The Butterflies of Uzbekistan (Lepidoptera, Rhopalocera). – Tshikolovets, Brno-Kyiv. 400 pp., 49 pls.

Tshikolovets, V. V. 2003. The Butterflies of Palaearctic Asia. IV. The Butterflies of Tajikistan (Lepidoptera, Rhopalocera). – Tshikolovets, Brno-Kyiv. 500 pp., 77 pls.

Tshikolovets, V. V. 2005a. The Butterflies of Palaearctic Asia. V. The Butterflies of Ladak (N.-W. India) (Lepidoptera, Rhopalocera). – Tshikolovets, Brno-Kyiv. 176 pp., 30 pls.

Tshikolovets, V. V. 2005b. The Butterflies of Palaearctic Asia. VI. The Butterflies of Kyrgyzstan (Lepidoptera, Rhopalocera). – Tshikolovets, Brno-Kyiv. 511 pp., 108 pls.

Tuzov, V. K. (Ed.) 1997. Guide to the Butterflies of Russia and Adjacent Territories. Vol. 1. Hesperiidae, Papilionidae, Pieridae, Satyridae. – Pensoft, Sofia, Bulgaria. 480 pp., 78 pls.

Tytler, H. C. 1926. Notes on some new interesting butterflies from India and Burma, pt. 1. – Journal of the Bombay Natural History Society **31**(2): 248–260.

Wakeham-Dawson, A. 2006. Descriptions of wing androconia from some *Pseudochazara* de Lesse, 1951 (Lepidoptera: Nymphalidae, Satyrinae) type specimens in The Natural History Museum, London. – Entomologist's Gazette **57**: 99–107.

Wakeham-Dawson, A. & R. L. H. Dennis 2001. A quantitative description of the male genitalia of 23 taxa of *Pseudochazara* de Lesse, 1951 (Lepidoptera: Nymphalidae, Satyrinae). – Entomologist's Gazette **52**: 227–250.

Wakeham-Dawson, A. & O. Kudrna 2000. A quantitative description of androconia from Staudinger's *Pseudochazara* de Lesse, 1951 (Lepidoptera: Nymphalidae, Satyrinae) type specimens in the Zoological Museum of the Humboldt University of Berlin. – Entomologist's Gazette **51**: 75–81.

Wakeham-Dawson, A. & O. Kudrna 2005. Further descriptions of androconia from Staudinger's *Pseudochazara* de Lesse, 1951 (Lepidoptera: Nymphalidae, Satyrinae) type specimens in the Zoologisches Museum der Humboldt-Universität zu Berlin. – Entomologist's Gazette **56**: 139–146.

Wakeham-Dawson, A. & O. Kudrna 2006. Description of wing androconia from the lectotype of *Pseudochazara caucasica* (Lederer, 1864) (Lepidoptera: Nymphalidae, Satyrinae), with notes on the topotype wing androconia of related taxa. – Entomologist's Gazette **57**: 137–141.

Wakeham-Dawson, A., P. Jaksic, J. D. Holloway & R. L. H. Dennis 2004. Multivariate analysis of male genital structures in the *Hipparchia semele-muelleri-delattini* complex (Lepidoptera: Nymphalidae, Satyrinae) from the Balkans: how many taxa? – Nota lepidopterologica **27**(2/3): 103–124.

Wakeham-Dawson, A., R. Parker, E. John & R. L. H. Dennis 2003. Comparison of the male genitalia and androconia of *Pseudochazara anthelea acamanthis* (Rebel, 1916) from Cyprus, *Pseudochazara anthelea anthelea* (Hübner, 1924) from mainland Turkey and *Pseudochazara anthelea amalthea* (Frivaldsky, 1845) from mainland Greece (Lepidoptera: Nymphalidae, Satyrinae). – Nota lepidopterologica **25**(4): 251–263.

Warren, B. C. S. 1963. Monograph of the Genus *Erebia*. – BMNH, London. vii + 407 pp., 104 pls.

Wyatt, C. & K. Omoto 1966. New Lepidoptera from Afghanistan [1.]. – Entomops **5**: 138–167.