

**Notes on the high Andean cloud forest butterfly genus
Jagiello and its relatives with description of a
new species from Peru (Lepidoptera: Lycaenidae)**

ZS. BÁLINT¹, K. KERTÉSZ² & J. WOJTUSIAK³

¹ Department of Zoology, Hungarian Natural History Museum,
H-1088 Budapest, Baross u. 13, Hungary. E-mail: balint@nhmus.hu

² Department of Nanotechnology, Research Institute for Technical Physics
and Material Science, H-1525 Budapest, POB 49, Hungary.
E-mail: kertesz@mfa.kfki.hu

³ Zoological Museum of the Jagiellonian University,
Incardena 6, 30-060 Kraków, Poland. E-mail: wojt@zuk.iz.uj.edu.pl

Abstract – The generic names *Jagiello* BÁLINT et WOJTUSIAK, 2000 and *Trochusinus* JOHNSON, SALAZAR et VÉLEZ, 1997 are reinstated from the synonymy of *Timaeta* JOHNSON, KRUSE et KROENLEIN, 1997 on the basis of unique characters. The hitherto unknown female of *Timaeta christina* ROBBINS et BUSBY, 2008 is characterized and illustrated. A new species, *Jagiello boyeropampa* sp. n., is described from southern Peru. A key for identification of species of *Timaeta* and *Jagiello* is presented. The diagnostic characters of *Jagiello*, *Timaeta* and *Trochusinus* are discussed, the character states are tabulated, and a new concept is proposed for their recognition resulting in eight new nomenclatural combinations: *Trochusinus aepea* (HEWITSON, 1874) comb. n., *T. cospata* (ROBBINS et BUSBY, 2008) comb. n., *T. gabriela* (BUSBY et ROBBINS, 2008) comb. n., *T. matthewi* (BUSBY et ROBBINS, 2008) comb. n., *T. pilosa* (ROBBINS et BUSBY, 2008) comb. n., *T. roberti* (BUSBY et ROBBINS, 2008) comb. n., *T. romero* (ROBBINS et BUSBY, 2008) comb. n. and *T. walteri* (BUSBY et ROBBINS, 2008) comb. n. With 32 figures and one table.

Key words – Reinstated generic names, female phenotype, new species, new combinations, characters, taxonomic diversity, systematic uniformity.

INTRODUCTION

The name *Jagiello* was proposed as a monotypic genus with the type species *Jagiello molinopampa* BÁLINT et WOJTUSIAK, 2000. The species and the genus were diagnosed by comparison with *Micandra* SCHATZ, 1888 and *Trochusinus* JOHNSON, SALAZAR et VÉLEZ, 1997 suggesting possible close relationships of these genera (BÁLINT & WOJTUSIAK 2000: 187–188). Subsequently, it was discovered that the female allotype of *J. molinopampa*, which was associated with the male holotype, belonged to a different species (BÁLINT, BOYER & WOJTUSIAK 2006).

The two generic names, *Jagiello* and *Trochusinus*, were listed by ROBBINS (2004) as synonyms of *Timaeta* JOHNSON, KRUSE et KROENLEIN, 1997 and placed in the “*Micandra* section” without any accompanying diagnostic notes. These nomenclatural decisions were confirmed later in the revision by ROBBINS & BUSBY (2008), who presented data to support their point of view. Brief diagnosis of “*Micandra* section” and a wider concept for *Timaeta* was introduced by quoting three characters. Authors also mentioned that “...recognizing *Jagiello* would require new concepts for the genera *Timaeta* and *Trochusinus*”.

In this paper we reinstate the generic name *Jagiello* and present new concepts for genera *Timaeta* and *Trochusinus*. The reason for the proposed changes was that some characters used by ROBBINS & BUSBY (2008) to support wide *Timaeta* concept were not properly interpreted and coded. Moreover, we have also found additional characters, which enabled us to revise the previous decisions. As a result, we can diagnose *Jagiello* unambiguously, restrict the generic name *Timaeta* to the “clade” *christina-timaeus*, and apply the name *Trochusinus* for the group of twelve species clustered in monophyly within the wide *Timaeta* concept.

As a result of our research we propose a new key for identification, briefly characterize the hitherto unknown female of *T. christina* and describe a new species within the genus *Jagiello*, which therefore ceases to be monobasic. These are followed by a brief discussion on generic concepts outlined in the key and a presentation of hypothetical apomorphic character states for the distinguished genera. We also add some notes on bionomics of the group and on the monophyly of *Timaeta sensu* ROBBINS et BUSBY and optical properties of *Jagiello*. Finally, we present a checklist containing all newly proposed nomenclatural combinations.

MATERIAL AND METHODS

The material we used for diagnosing the hitherto unknown female and the new species of *Jagiello* are listed in "Descriptions". The data of the material used in our studies are given separately as closing chapter.

Methods and terminology remained the same as in our earlier papers on Neotropical eumaeine lycaenids (e.g. BÁLINT 2010, BÁLINT & FAYNEL 2008, BÁLINT, KERTÉSZ & WOJTUSIAK 2006, BÁLINT & WOJTUSIAK 2000).

Optical properties of the light reflected from wings were measured by means of a recently developed equipment – a spectroboard (BÁLINT *et al.* 2010). Photomicrographs were taken on OLYMPUS SZX9 optical microscope and Hitachi F-4700 Scanning Electron Microscope.

Collection acronyms – BMNH = The Natural History Museum, London, United Kingdom; CPB = private collection of PIERRE BOYER, Le Puy-Sainte-Réparade, France; HNHM = Magyar Természettudományi Múzeum (Hungarian Natural History Museum), Budapest, Hungary; MIZA = Museo del Instituto de Zoología Agrícola, Universidad Central de Venezuela, Maracay, Venezuela; MUSM = Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru; MZUJ = Muzeum Zoologiczne Uniwersytetu Jagiellońskiego (Zoological Museum, Jagiellonian University), Kraków, Poland; UNCC = Museo de Historia Natural, Universidad Nacional de Caldas, Manizales, Colombia; USNM = National Museum of Natural History, Smithsonian Institution, Washington DC, USA.

KEY FOR IDENTIFICATION OF THE GENERA *JAGIELLO*, *TIMAETA* AND *TROCHUSINUS* AND THE SPECIES OF *JAGIELLO* AND *TIMAETA*

- 1 Male forewing with androconia, hindwing membrane with three medial veins; female phenotype hindwing tailed at terminus of vein 2A, or not tailed, but with scalloped margin 2
- Male forewing without androconia, hindwing membrane with two medial veins (M2 missing); female phenotype hindwing tailed at vein termini of CuA1 and CuA2, or not tailed with smooth margin
Trochusinus JOHNSON, SALAZAR et VÉLEZ, 1997
- 2 Male body dorsally blue; ventral forewing with blue reflector restricted to the area along the vein Cu plus a scent patch posterior to Cu comprised by deep brown androconia; hindwing dorsum with subbasal absorber, posterior abdomen black; female phenotype tailed at hindwing vein terminus CuA2 3

- Male body dorsally black; ventral forewing with extensive blue reflector in area between veins Radius and Cu2 with minute postdiscal scent patch distally between veins M3 and CuA1; hindwing without absorber, posterior abdomen reddish brown; female hindwing margin scalloped without tail 4
- 3 Male hindwing inner margin convexity incomplete (posteriorly slightly concave) with well pronounced tornal angle, female with dorsal violet colouration *Timaeta christina* ROBBINS et BUSBY, 2008
- Male hindwing inner margin completely convex without tornal angle, female phenotype with azure dorsal colouration
Timaeta timaeus (FELDER et FELDER, 1865)
- 4 Male dorsal forewing with deep blue colouration extending to submarginal area; hindwing in submedian area blue between veins M1 and M3, outer margin slightly scalloped
Jagiello molinopampa BÁLINT et WOJTUSIAK, 2000
- Male dorsal forewing with violet colouration restricted to the discal and posterio-discal areas, hindwing in submedian area black between vein M1 and M3, outer margin deeply scalloped
Jagiello boyeropampa sp. n.

DESCRIPTIONS

Timaeta christina ROBBINS et BUSBY, 2008, female
(Figs 1–2)

Material examined – A single specimen (CPB) labelled as “Jose Böttger Leg [/] La Antena, SE [/] d’Oxapampa, 2700 m [/] (Oxapampa (Pasco) [/] PEROU [/] Avril 2005”.

Description – Colouration and pattern similar as in male, but differs in (1) lacking androconia (there are no reflector and absorber scales), (2) having a long tail at hindwing vein Cu2 terminus (male outer margin straight without tail) and (3) ventral wingsurface ground colouration warm brown (male ground colouration deeper brown with forewing blue reflector scales along the cubital vein).

Bionomics – The specimen was collected when hilltopping at 2700 m in April.

Remarks – We associate this female with *Timaeta christina* (Figs 3–4). The sister species *T. timaeus* shows a similar degree of sexual dimorphism: ventral wing pattern is

identical in both sexes, the hindwing is differently shaped as the vein CuA₂ terminus is tailed in the female (*cf.* GOODSON 1946, D'ABRERA 1995: 1132, figs "T. timaeus", ROBBINS & BUSBY 2008: figs 1–2). We note here that the female of *T. christina* has also a brown cubital spot similar to that of the male. Therefore the ventral hindwing cubital spot, which appears to be differently coloured in the male and the female, cannot be considered as a diagnostic character for *Timaeta*.

This first record of the female widens the most southern range of distribution of the species, known from records of three males from department of Amazonas in Peru, and eight males from the Ecuadorian provinces Tungurahua and Zamora-Chinchipe (see ROBBINS & BUSBY 2008: 212 and Data of Material Examined).



Figs 1–4. *Timaeta christina* ROBBINS et BUSBY, 2008. 1 = the first known female, Peru, dep. Pasco (dorsum), 2 = ditto (ventrum), 3 = male, Ecuador, prov. Zamora (dorsum), 4 = ditto, ventrum

Jagiello boyeropampa BÁLINT et WOJTUSIAK, sp. n.
(Figs 6, 8, 10, 12, 22–23)

Type material – Holotype: male, labelled as “Pierre Boyer leg., Acjanaco vers Boca, Manu km 2 à 6 (Cuzco), 3300/3470 m PEROU, 22/05/03” (Figs 22–23). The specimen is in good condition. At present it is in MZUJ, but will be deposited in MUSM.

Paratypes: males (nos 1–2, MZUJ, both measured on spectroboard) all from Peru: Dept. Cuzco, Paucartambo, Abra Acjanaco vers Pillcopata, km 10, 3000–3100 m, 24.II.2005, PIERRE BOYER leg. (no. 1., set dorsally, slightly worn specimen: forewing apex missing; abdomen dissected); Dept. Cuzco, Acjanaco-Pillcopata, Qda. Toccohuayco, 3300–3400 m, 22.V.2003, leg. T. PYRCZ (no. 2. in moderate condition, set dorsally, wings slightly worn, left antenna tip missing, abdomen dissected). Males (nos 3–10, CPB): Acjanaco vers Boca Manu km 2 à 6, (Cuzco), 3300–3470 m, 22.V.2003, P. BOYER leg. (no. 3); Acjanaco vers Pilcopata km 10, (Paucartambo, Cuzco), 3000–3100 m, 24.II.2005, P. BOYER leg. (nos 4–5); Acjanaco vers Boca Manu km 10, (Cuzco), 3000 m, IV. 2005, JOSE BÖTTGER leg. (no. 6); Acjanaco vers Boca Manu, (Cuzco), 3000 m, 15.IV.2005, OLIVIER DUVIOLS leg. (nos 7–9); Acjanaco vers Boca Manu, (Cuzco), 3000 m, 19.IV.2005, OLIVIER DUVIOLS leg. (no. 10). Male (no. 11, HNHM, measured on spectroboard), same data as holotype, specimen set dorsally, in moderate condition, right hindwing tornal part missing.

Description – Male. Wing venation, and general colouration pattern (Figs 22–29), as in type species, *J. molinopampa*; doubled row of cilia (Figs 7–8); posterior abdomen reddish brown (Figs 5–6); ventral forewing surface with blue reflector; ventral hindwing surface with markings unique in the tribe (Fig. 23), wings and body size as in *J. molinopampa*. Mean forewing length 14.5 mm ($n = 3$); androconia, as in *J. molinopampa*, present on ventral forewing surface in cell veins M3–CuA1 distally to discal cell apex in form of a minute scent patch (Figs 9–10), male genitalia as in *J. molinopampa* (Figs 11–12) with large tegumenal plate, extensive vincular lobe and a saccus equal in length with subzonal aedeagus; suprazonal aedeagus straight. Female not known.

Diagnosis – *J. boyeropampa* and *J. molinopampa* males differ in the following:

1) Structural colouration of the dorsal wingsurfaces. Forewing blue colouration is restricted to discal and posterior discal areas in *J. boyeropampa* and the black colour of the distal margin covers the whole remaining area slightly extending basally along the vein Cu. It results in a pattern of basally undulated margin of the blue area (blue scales cover the whole *J. molinopampa* forewing surface to the distal black margin). The margin extends only to the submedian area without black Cu scaling. The blue spot has a curved and continuous basal margin bordering the blue area; hindwing postdiscal area between veins M1 to M3 is black (it is blue in *J. molinopampa*) (Fig. 22).

2) Extension of androconia. The scent patch in *J. boyeropampa* is restricted to the area very close to the point where veins M3 and Cu1 are erecting, therefore the surface of the scent patch is minute; it is larger and wider in *J. molinopampa*, and the scent patch extends distally at least two times further between the veins M3 and Cu1 (Figs 9–10).

3) Hindwing shape. The outer margin between vein termini Cu1 and A3 is deeply scalloped intervenially in *J. boyeropampa*; this character is especially well developed in the Cu2 and A3 interventional area, which is always concave (hollowed basally) in *J. boyeropampa*, but straight in *J. molinopampa* (Fig. 23).

Bionomics – Known only from type data. Specimens were collected in February, April and May between elevations of 3000 and 3470 m.

Etymology – The name is dedicated to Mr. PIERRE BOYER, collector of the holotype, and the suffix “pampa” is attached to his name in genitive rhyming with congener *J. molinopampa*.



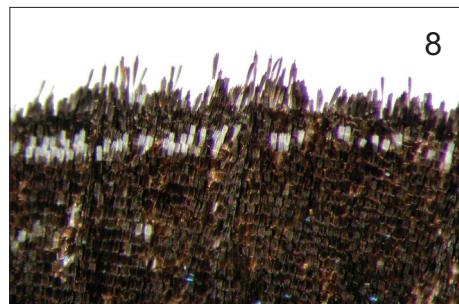
5



6

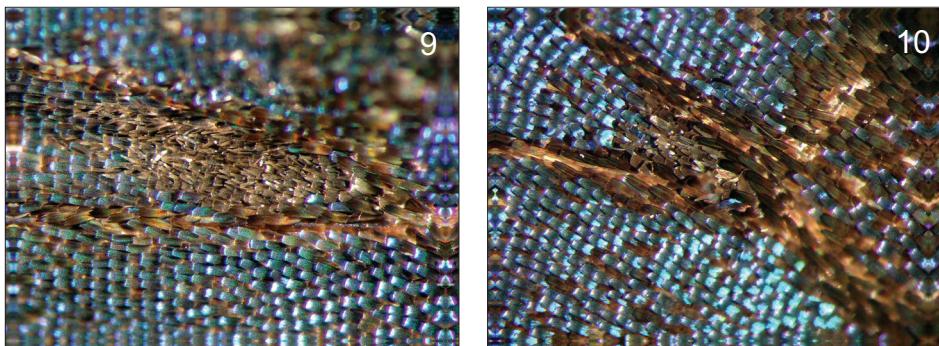


7



8

Figs 5–8. Characters in the genus *Jagielo* BÁLINT et WOJTUSIAK, 2000. 5–6. Male red abdominal scaling in dorsal view: 5 = *J. molinopampa* BÁLINT et WOJTUSIAK, 2000, 6 = *J. boyeropampa* sp. n. (paratype). 7–8. Double ciliation in ventral wing surfaces: 7 = *J. molinopampa*, 8 = *J. boyeropampa* (paratype)



Figs 9–10. Characters in the genus *Jagiello* BÁLINT et WOJTUSIAK, 2000. Ventral forewing scent patch in the space distal to the forewing cell between veins Media3 and Cubitus1 represented by a grey cluster of small androconial scales and surrounded by larger cover scales generating blue structural colour: 9 = *J. molinopampa* (Peru), 10 = *J. boyeropampa* (paratype)

Remarks – The colour pattern of dorsal surface of wings, different to that of *J. molinopampa*, (character 1) may be a source of species specific visual sex recognition signal when light is reflected from wings during the flight for conspecific females (see Discussion).

We remark that even such a minute difference as the surface extension of androconia (character 2), what can be detected between the two *Jagiello* species, is sufficient enough to play a role in sex recognition when the scent patch site is touched by female receptors on the tip of antenna in the last stage of courtship.

The remaining distinguishing character (no. 3) most probably has a role of the defensive behaviour of the species (camouflaging, hiding or mimicking).

DISCUSSION

Reinstating the genus *Jagiello*

The genus *Jagiello* was established on the basis of three features: the wing venation, the peculiar and tailless wingshape in both sexes and the unique colouration pattern of the ventral hindwing surfaces. The *Jagiello* androconial system was misinterpreted. In the original *Jagiello* diagnosis the remark “no androconia” was given by BÁLINT & WOJTUSIAK (2000: 188) as well as in the subsequent revision of ROBBINS & BUSBY (2008: 209, in the wing pattern key for male *Timaeta*). In this latter paper contradictory indications as “no evident androconia” (ROBBINS & BUSBY 2008: 212, in the characterization of *Timaeta molinopampa*) and “androconia at base of dorsal hindwing and ventral forewing present” (ROBBINS & BUSBY 2008: 231 in

the character matrix for Table 1. fig. 74, 230 as character no. 13; in the coded characters for Table 1 and 228 in the cladogram fig. 74) were also given.

Instead, there is a different androconial patch on the ventral side of the postdiscal area (Figs 9–10). Because of their small size, these androconia remained unnoticed until recently. It is a scent patch *sensu* ROBBINS (1991), because it does not leave any mark on the wing membrane. It is comprised of androconial scales which are similar in size, micro- and nanostructure to those scales in other Eumaeini. The scales measure approximately 120–140 µ in length and 10 µ in width and their surface is sculptured by longitudinal ridges, distanced from each other by one micrometer gap (Figs 13–16). We regard this kind of androconia in *Jagiello* as unique character in the monophyly of *Micandra* section, because as far as we know, there are no similar scent patches in any of the taxa placed in the *Micandra* section and in any other genera within the tribe which are situated on forewing ventral surface in postdiscal intervenial area bordered by veins R3–Cu1. The structural colour generating system of scales is commonplace in *Jagiello* (Figs 17–20).

The *Jagiello* androconial system is different from the complex androconial system of *Timaeta*. Therefore it is more logical to consider those androconia to be newly derived (apomorphic) than ancestral (plesiomorphic).

Table 1. Distribution of selected male character states in the genera *Jagiello*, *Micandra*, *Phothecla*, *Timaeta* and *Trochusinus*

	Character 1	Character 2	Character 3	Character 4	Character 5	Character 6	Character 7
<i>Jagiello</i>	2	1	0	2	0	0	1
<i>Micandra</i>	2	1	1	0	0	1	2
<i>Phothecla</i>	0	0	0	0	0	1	2
<i>Timaeta</i>	1	2	0	1	1	1	2
<i>Trochusinus</i>	2	2	0	0	2	1	2

Character 1 – ventral forewing surface: without reflector = 0, with reflector restricted to the cubitus = 1, not restricted to the cubitus = 2 (male *Phothecla* forewing ventral surface excluding marginal area is structurally green, but it does not function as a reflector)

Characer 2 – ventral forewing surface: without blue reflector = 0, with the dorsal wing surface blue structural colour = 1, with different structural blue colour than dorsal wing surface = 2

Character 3 – dorsal forewing surface: without androconia = 0, with androconia = 1

Character 4 – ventral forewing surface: without androconia = 0, with cubital androconia = 1, with postmedian androconia = 2

Character 5 – dorsal hindwing surface: without androconia = 0, with absorber androconia = 1, with pilose scale androconia = 2

Character 6 – thorax and abdomen dorsal surface: without structural colouration = 0, with structural colouration = 1

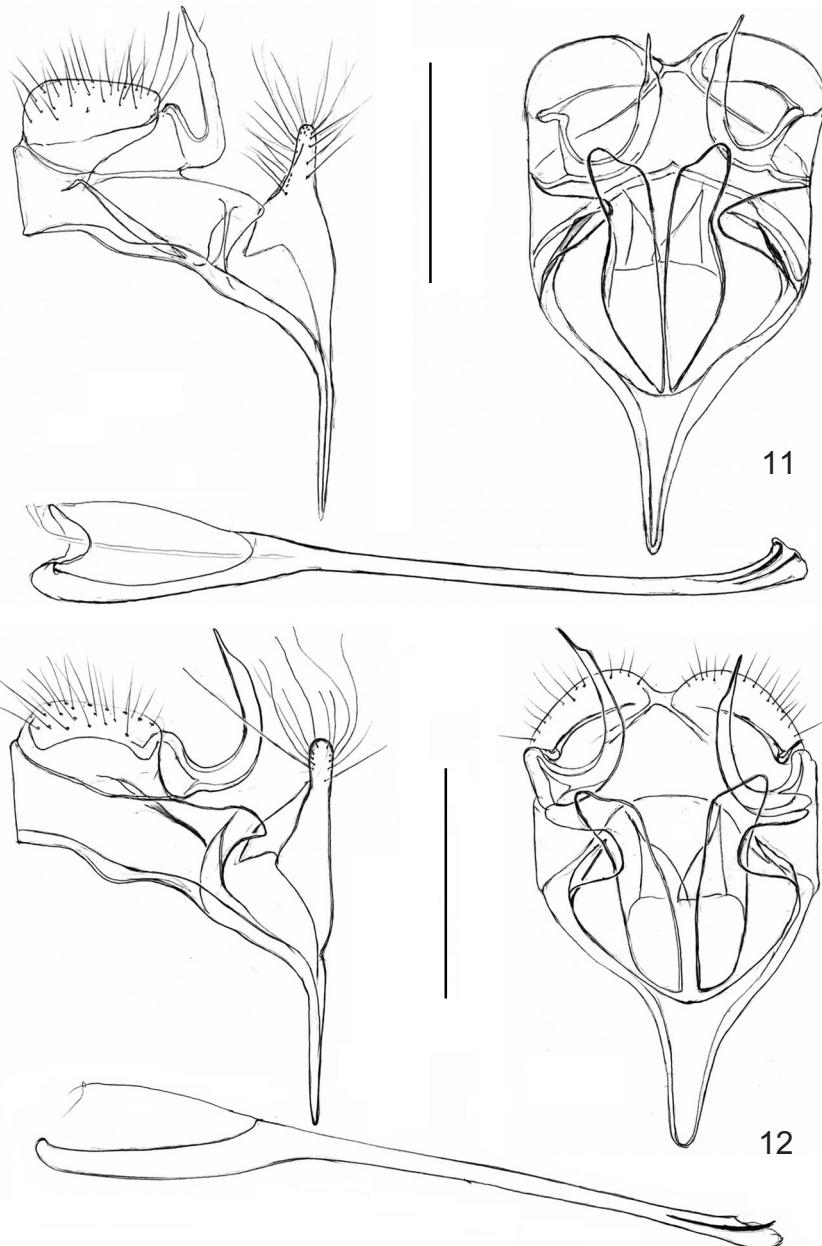
Character 7 – male abdomen tip dorsally red = 1, dorsally blue = 2

As we are aware the hindwing ventral pattern and the entire reddish brown posterior scaling of the male abdomen are also unique in the “*Micandra*” assemblage of eumaeine lycaenids. Therefore, we hypothesize that for *Jagiello* these are also apomorphies. On the basis of all three characters (androconia, hindwing pattern and abdominal scaling) we remove the generic name *Jagiello* from the synonymy of *Timaeta*. Without providing a phylogenetic analysis, hence we cannot speculate about the hypothetical sister group of *Jagiello*: just mention that according to the characters listed in Table 1, *Micandra*, *Timaeta* (*sensu stricto*) and *Trochusinus* can be considered as sister groups in an equally plausible way.

New concept of *Timaeta*

ROBBINS & BUSBY (2008) proposed a wide concept of *Timaeta* based on three character states by the following two lineages: *molinopampa-timaeus-christina* and another with a dozen or so species.

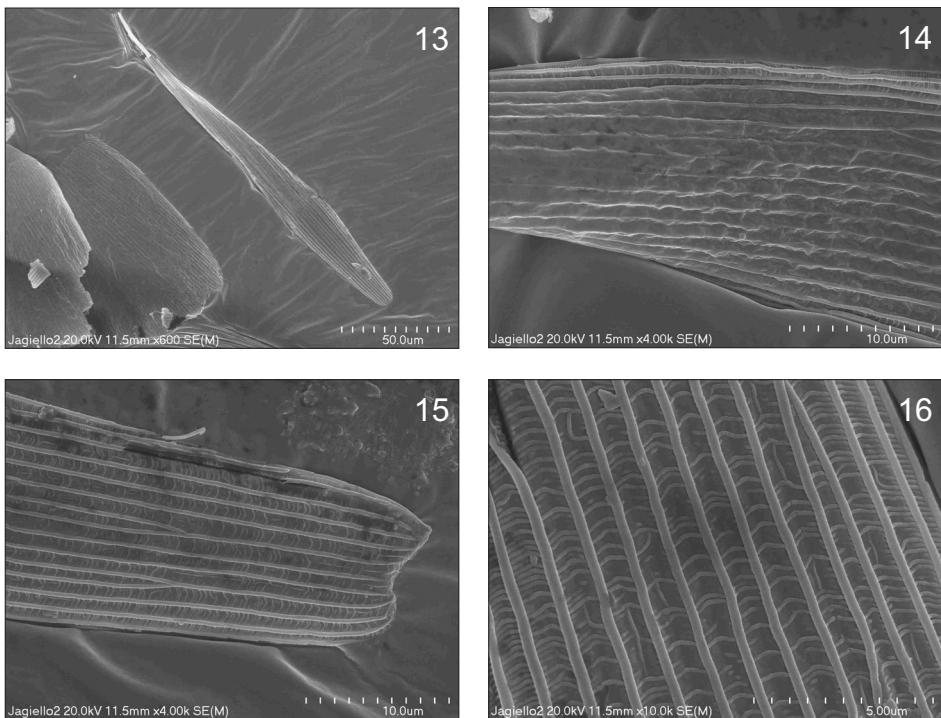
One of the characters is genital, the remaining two are wing pattern elements. The male genital character (“posterior edge of labides in lateral aspect dorso-ventrally flat”) is hard to define, as indicates the “greyhound-shaped” genital character typical for the tribe and its relatives (see CLENCH 1971, ELIOT 1973). Moreover, the *Jagiello* male genitalia (Figs 9–10) are not flat ventrally in lateral aspect as *Timaeta* and certain *Trochusinus* when compared with figures 36–43 presented by ROBBINS & BUSBY (2008). The first wing pattern element, namely “the brown male ventral hindwing cubital spot” is reversed in certain “*Timaeta*” species as it was indicated (see above), therefore this character does not provide convincing evidence to support hypothetical monophyly. Similarly, the other wing character “male hindwing tails absent”, weakly supports common descent, because the closely related *Micandra platyptera* STAUDINGER, 1888 has tailless male and tailed female phenotypes (D’ABRERA 1995: 1133) and all the other species transferred to *Micandra* from other genera by ROBBINS (2004) have males with tails.



Figs 11–12. Male genital armatures of *Jagiello* BÁLINT et WOJTUSIAK, 2000 species, top left in lateral view and top right in ventral view with removed aedeagus, below aedeagus in lateral view (scale bars = 1 mm): 11 = *J. molinopampa* BÁLINT et WOJTUSIAK, 2000 (Peru), 12 = *J. boyeropampa* sp. n. (paratype)

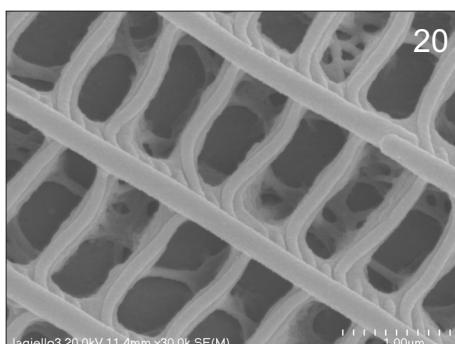
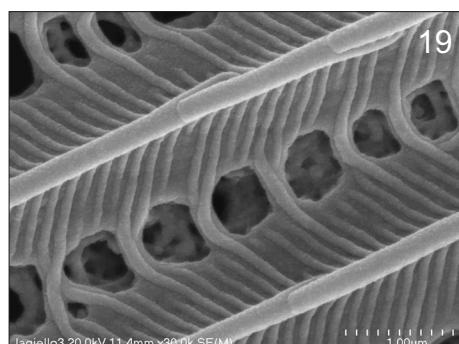
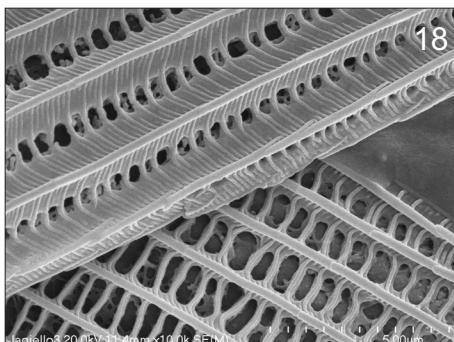
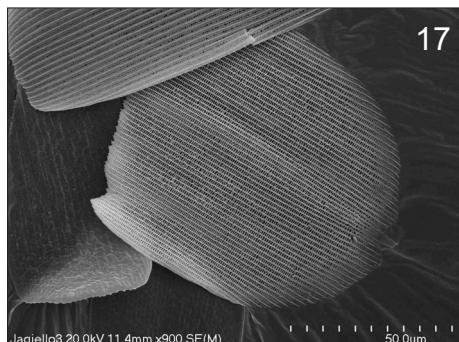
Consequently, the wide concept for *Timaeta* is not satisfactory, but a narrow application of the name is not causing any controversy. Therefore our *Timaeta* concept is restricted to the sister-species pair *christina-timaeus*, and is defined by the following character states:

- 1) ventral forewing apical area with white marginal spots in the area bordered by cells of veins R3 and M3 (Figs 2, 4);
- 2) male ventral forewing surface with cubital androconia and blue reflector restricted to discal area (Fig. 4);
- 3) male dorsal hindwing surface in subbasal area with an absorber (Fig. 3);
- 4) male genital saccus longer than subzonal aedeagus.



Figs 13–16. Scanning electron micrographs of *Jagiello molinopampa* androconial scale: 13 = a single long androconial scale in dorsal view (in the left corner there are two cover scales, one of them is a partly covered, the other one is broken) (scale bar: 50 μ), 14 = the folded lower part of the same androconial scale showing the ventral side of the scale in larger magnification (scale bar: 10 μ), 15 = the apical part of the same androconial scale showing longitudinal ridges and crossribs with no further structures (scale bar: 10 μ), 16 = enlarged view of the androconial scale dorsal surface showing the microstructures (scale bar: 5 μ)

According to our best knowledge, character states 1 and 4 do not occur in the taxa placed in the *Micandra* section. Character states 2 and 3 can be found in other taxa in *Micandra* section and also in other genera, as for example *Annamaria*, *Brangas*, *Dabreras*, *Rhamma* representing other eumaeine sections of ROBBINS (2004). Without mapping the distributions of these character states in other eumaeine clusters it cannot be judged whether they are hypothetically plesiomorphic or homoplastic.



Figs 17–20. Scanning electron micrographs of *Jagiello molinopampa* BÁLINT et WOJTUSIAK, 2000 regular scales: 17 = shovel shaped ground scale in the center, longer cover scales in the left side and in the upper left side (partly covering the ground scale) (scale bar: 50 μ), 18 = cover scale in the upper part and ground scale in the lower part showing microstructures (scale bar: 5 μ), 19 = blue colour generating cover scale microstructures: longitudinal ridges with scutes, cross- and microribs and windows revealing the internal three dimensional architectures of the scale body working as photonic crystals (scale bar: 1 μ), 20 = pigment packed ground scale microstructures: longitudinal ridges, scutes, microribs and windows showing disordered porous elements packed with pigments (scale bar: 1 μ)

Reinstating of *Trochusinus*

Although JOHNSON and his colleagues did not sufficiently characterize *Trochusinus* (see JOHNSON *et al.* 1997), selection of *Thecla trochus* as a type species was lucky. In this species the hindwing vein M2 is absent, and the wing colouration, pattern and shape together are well representing the group of a dozen species looking more similar to each other than to any other eumaeine species (ROBBINS & BUSBY (2008) character no. 16, or node B in their fig. 74). It was even mentioned in the wide *Timaeta* concept that «the “loss” of hindwing vein M2 in both sexes is an excellent generic character in those twelve *Timaeta* species in which it occurs» (ROBBINS & BUSBY 2008: 208). We consider this as a synapomorphy for all the taxa representing *Trochusinus* as it does not occur in any other species of the *Micandra* section and therefore, we reinstate the generic name from synonymy on the basis of this uniqueness in the group. None of the *Trochusinus* males has blue reflector identical to *Jagiello* or *Timaeta*, which means that the mechanisms of their optical systems are qualitatively different (see below).

It was also mentioned that the androconia, discovered in “*Thecla eronos*” by DRAUDT as “der untere Medianast der Hfgl [= Hinterflügel] trägt einen langen Haarbesatz” (DRAUDT 1919: 756; plate 53, row c, figs “*eronos*”), with the additional character, which is the male blue frons, distinguishes a group of five species within the genus (= *Timaeta eronos* species group of ROBBINS & BUSBY). The remaining seven species of the “*Timaeta trochus* species-group” do not have these two clear-cut characters. Although we consider the absence and presence of the androconia to be an important taxonomic character, in the case of these seven *Trochusinus* species this character distribution among them is not well documented. Our material is limited, therefore at this moment we do not propose further generic name to clarify the taxonomy of the group. Also, in the analysis presented by ROBBINS & BUSBY (2008) the hindwing dorsal androconia along the vein CuA2 appear in the most “derived” group. This statement is in harmony with the results of HALL & HARVEY (2002), who note that the taxa of Riodinidae with most complex androconia are the presumably the most derived ones.

Notes on the blue reflectors

The males of all the three genera discussed in the present paper possess scalings in the dorsal and ventral forewing surfaces which generate structural blue colouration (see Table 1). These colours can be seen during flight as the entire dorsal wingsurface and the ventral forewing surface in resting eumaeine lycaenids are generally hidden between the closed hindwings. Therefore it is hypothesised that these blue scalings, combined with their function as reflectors, are emitting species specific three dimensional optical signals (cf. BIRÓ & VIGNERON 2010: 23).

We measured the spectral characteristics of light reflected from wings of eight *Jagiello* specimens (Fig. 21). The measurements revealed that the structural colours generated by both wing surfaces are almost identical in their spectral and reflectance properties, excluding a single sample originating from the western cordilleras of Ecuador. The two specimens of *J. boyeropampa* do not show any spectral characteristic although for the naked human eye the colour they emit seems to be different from that of *J. molinopampa* (Figs 22–29). This is most probably due to the smaller number of structural colour generating scales mixed with pigment packed brown scales on the dorsal wing surfaces resulting in a darker impression. In contrast, the ventral forewing blue reflectors are identical in both species. Therefore both of the species in flight are able to emit almost continuous visual signal because spectral and reflective properties are almost identical for both surfaces. However, the extension of structural colours on the dorsal wing surfaces is grossly contrasting and this results a different signal in flight. For example the signal of *J. boyeropampa* is most probably more oscillate than *J. molinopampa* signal (if we presume that the wingbeat speed of the two species is identical). The more metallic blue of the western Ecuadorian specimen (Figs 28–29) could be detected spectroscopically, but because of the limited number of samples (this is the only known *Jagiello* specimen from the western cordilleras) we do not know whether it is an individual variation or represents a distinct taxon. There are numerous examples in Lepidoptera for sister taxon relationships in the eastern and western cordilleras of southern Ecuador.

The measurements completed on male *Trochusinus* revealed that the ventral wing surface is far more reflective and its colour spectrum is displaced when compared to that of the dorsal surface (Fig. 30). This suggests

that visual signals emitted during flight are not uniform in their physical characteristics but appear rather as an alternating oscillation of the two different blue colours.

This is especially well visible in *Trochusinus apaea* and *T. romero* where the spectral peak of the ventral blue reflector is shifted toward the deep blue and close to the ultra violet.

Even more contrasting are visual signals emitted from *Timaeta* ventral forewing cubital reflector in combination with the dorsal reflection pattern.

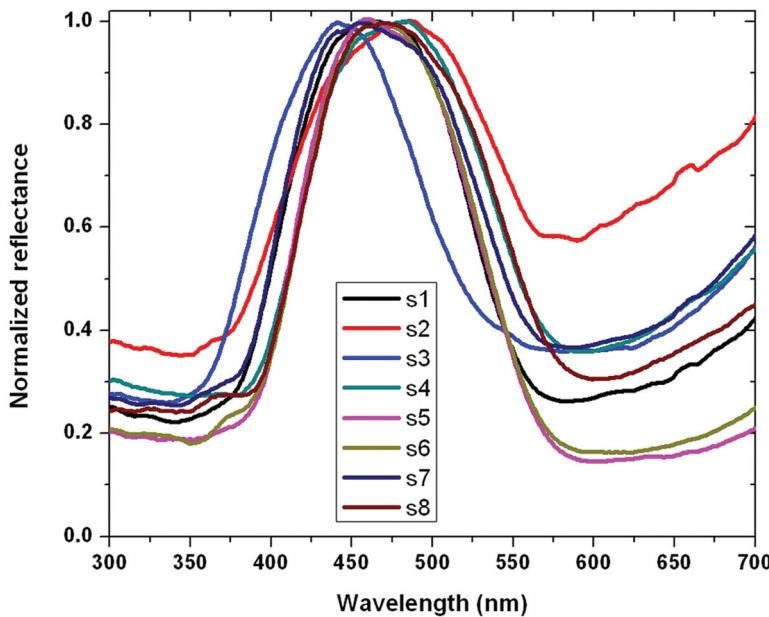


Fig. 21. Individual reflectance spectra(s) of eight *Jagiello* BÁLINT et WOJTUSIAK, 2000 male specimens measured under normal incidence in the discal cell area of the forewings using spectroboard: s1 = *J. boyeropampa* sp. n. (Peru, dep. Cuzco), s2 = *J. boyeropampa* sp. n (Peru, dep. Cuzco), s3 = *J. molinopampa* BÁLINT et WOJTUSIAK, 2000 (Ecuador, prov. Azuay), s4 = *J. molinopampa* (Ecuador, prov. Loja), s5-s8 = *J. molinopampa* (Peru, prov. Amazonas)

Fig. 22–29. *Jagiello* BÁLINT et WOJTUSIAK, 2000 species of various Andean regions, in dorsal (left column) and ventral (right column) views: 22–23 = *J. boyeropampa* sp. n. (holotype), 24–25 = *J. molinopampa* BÁLINT et WOJTUSIAK, 2000 (northern Peru, dep. Amazonas), 26–27 = *J. molinopampa* (southern Ecuador, eastern Cordilleras), 28–29 = *J. molinopampa* (southern Ecuador, western Cordilleras)



22



23



24



25



26



27



28



29

Such a difference in colouration must result in a strikingly different optical composition of the signals (Fig. 31) compared to *Jagiello* and *Trochusinus* (Fig. 32).

We may speculate that such visual, long distance signals may act as “first calls” for the females. In the next step however, olfactory signals are turning on. Only when the conspecific male pheromone is recognized by the female, the genital contact may start marking the end of courtship. This may explain the phenomenon that the genital structures of neotropical eumaeine hairstreaks are so uniform, and the structural colouration patterns and scent organs are so much differentiated. The evolution of such a diverse visual and chemical communication systems in Neotropical eumaeine butterflies may reflect their adaptation to the life in such a complex ecosystem, as it is the cloud forest of the Andes (cf. BÁLINT *et al.* 2009, ROBBINS & BUSBY 2009).

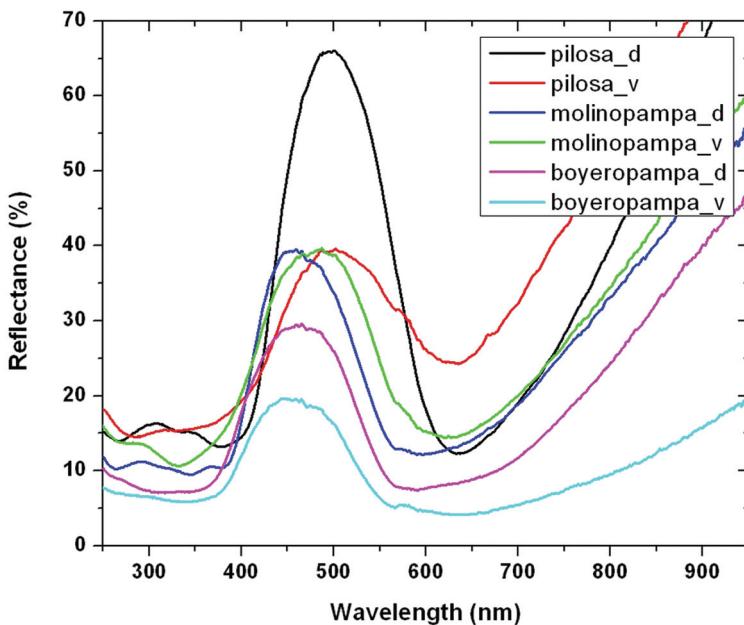


Fig. 30. Individual reflectance spectra of three neotropical eumaeine lycaenid butterfly males measured under normal incidence in the distal cell area of the forewings using spectroboard: d = dorsal wingsurface, v = ventral wingsurface, boyeropampa = *Jagiello boyero-pampa* sp. n., molinopampa = *Jagiello molinopampa* BÁLINT et WOJTUSIAK, 2000, pilosa = *Trochusinus pilosa* (ROBBINS et BUSBY, 2008)



Figs 31–32. Neotropical eumaeine lycaenid butterfly ventral forewing blue reflectors. 31 = the narrow “cubital reflector” of *Timaeta timaeus* (FELDER et FELDER, 1865) (situated along the vein Cubitus); 32 = the extensive “postmedial reflector” of *Trochusinus pilosa* (ROBBINS et BUSBY, 2008) (situated beyond the forewing cell)

Notes on the elevation and geographical occurrence of *Jagiello* and *Timaeta*

Specimens of *Jagiello molinopampa* have been recorded from the elevational zones between 2500 and 3200 m in various localities in south Ecuador and northeastern Peru. The *Jagiello* habitat is limited to montane ridges with bushes and occasional dwarf trees. According to our records *J. molinopampa* also occurs at slightly higher elevations in Ecuador. In the Peruvian Andes it occurs at the same elevation as *Timaeta timaeus*.

On the other hand, *Jagiello boyeropampa* occurs at higher elevations, between 3000 and 3470 m. On the basis of available records the two *Jagiello* species are parapatric, and there are no data for their sympatry.

Timaeta timaeus has been considered to occur in a montane forest between 1500 and 2200 m elevation and is distributed at various localities ranging from Venezuela to Bolivia (See Data of Material Examined). It is interesting that progressing toward the south of the Andes, the elevational ranges of this species shift to higher elevations reaching 2850 m in Peru (departments Amazonas and Huanuco).

Generic Nomenclature, Monophyly and Taxonomy

Recognition of the genera *Jagiello* and *Trochusinus* does not affect the hypothetical phylogeny expressed by the wide concept of *Timaeta*. However, as we tabulated some character states in the lineages recognized by us as genera (Table 1), this may suggest a different hypothetical history (phylogeny). But our goal with this paper was to stress the hypothesis that *Jagiello*, *Timaeta* and *Trochusinus* have different biology, what is obviously expressed by their different optical (wing colouration and pattern) and olfactory (androconial) systems. We doubt that lumping these three eumaeine clusters under the same generic name is a better solution from taxonomical point of view. Moreover we also doubt that taxonomic diversity on generic level is less important in the light of biological reality, than generic uniformity confirmed by hypothetical monophyly for evolutionary systematics.

TAXONOMIC CHECKLIST

Trochusinus JOHNSON et SALAZAR, 1997

- Trochusinus aepaea* (HEWITSON, 1874), **comb n.**; BMNH syntype female, ECUADOR: "Ecuador" (*Thecla*).
Trochusinus balzabamba (GOODSON, 1945) JOHNSON et SALAZAR, 1997; BMNH lectotype male (JOHNSON & SALAZAR 1997: 8), ECUADOR: "Ecuador" (*Thecla*).
Trochusinus cospata (ROBBINS et BUSBY, 2008), **comb. n.**; MUSM holotype male, PERU: "Cusco, Qda. Morro Leguia" (*Timaeta*).
Trochusinus eronus (H. H. DRUCE, 1907) JOHNSON et SALAZAR, 1997; BMNH holotype male, COLOMBIA: "Interior of Colombia" (*Thecla*).
Trochusinus gabriela (BUSBY et ROBBINS, 2008), **comb. n.**; USNM holotype male, ECUADOR: "Morona[-]Santiago, 14 km Limon-Gualaquiza Road" (*Timaeta*).
Trochusinus matthewi (BUSBY et ROBBINS, 2008), **comb. n.**; USNM holotype male, ECUADOR: "Morona-Santiago, 1 km E. Rio Abanico" (*Timaeta*).
Trochusinus pilosa (ROBBINS et BUSBY, 2008), **comb. n.**; USNM holotype male, ECUADOR: "Morona- Santiago, Nieve de Octubre" (*Timaeta*).
Trochusinus roberti (BUSBY et ROBBINS, 2008), **comb. n.**; USNM holotype male, ECUADOR: "Morona-Santiago, Nieve de Octubre" (*Timaeta*).
Trochusinus romero (ROBBINS et BUSBY, 2008), **comb. n.**; MIZA holotype male, VENEZUELA: "[Aragua], Choroni" (*Timaeta*).
Trochusinus trochus (H. H. DRUCE, 1907) JOHNSON et SALAZAR, 1997; BMNH holotype male, COLOMBIA: "Muzo, Rio Minero" (*Thecla*).

Trochusinus walteri (BUSBY et ROBBINS, 2008), comb. n.; USNM holotype male, ECUADOR: "Pichincha Province, 30 km, W. of Aloag" (*Timaeta*).

Trochusinus wernerii SALAZAR, VÉLEZ, CARDONA et K. JOHNSON, 1997; UNCC holotype male, COLOMBIA: "San José del Palmar".

Timaeta JOHNSON, KRUSE et KROENLEIN, 1997

Timaeta christina ROBBINS et BUSBY, 2008; MUSM holotype male, PERU: "AM [Amazonas], Mendoza, Quebrada Yanahuayco".

Timaeta timaeus (FELDER et FELDER, 1865) JOHNSON, KRUSE et KROENLEIN, 1997; BMNH lectotype female (JOHNSON, KRUSE & KROENLEIN 1997: 24), COLOMBIA: "Nova Granada" (= Colombia) (*Thecla*).

Jagiello BÁLINT et WOJTUSIAK, 2000

Jagiello boyeropampa BÁLINT et WOJTUSIAK, sp. n.; MUSM holotype male, PERU: "(Cusco). Acjanaco vers Boca, Manu km 2 à 6".

Jagiello molinopampa BÁLINT et WOJTUSIAK, 2000; MUSM holotype male, PERU: "Amazonas, Molinopampa, Via Granada".

DATA OF THE MATERIAL EXAMINED

Specimens marked by an asterisk (*) have been measured on the spectroboard.

Jagiello molinopampa BÁLINT et WOJTUSIAK, 2000 – ECUADOR (4 males): Prov. Azuay, Gualaceo vers Limon, km 7, 3200 m, 7.XII.2002, leg. P. BOYER (CPB, 1 male); Prov. Azuay, Gualaceo-Limon (West), 3100 m, 21.VIII.2003, leg. J. WOJTUSIAK (MZUJ, 1 male*; gen. prep. Jagiello nr. 4); Prov. Loja, Lagunillas, Amaluza vers Zumba, km 33, 3200–3300 m, 30.XI.2002, leg. P. BOYER (CPB, 1 male); Prov. Loja, Saraguro, via Las Antenas, 3200 m, 15.IX.2004, leg. WOJTUSIAK & PYRCZ (MZUJ, 1 male*, gen. prep. Jagiello no. 3). PERU (7 males, 2 females): Dep. Amazonas, Chachapoyas, Molinopampa-Granada, 3200 m, 28.VIII.1998, leg. T. PYRCZ (MZUJ, 1 paratype male*; gen. prep. Jagiello no. 6; HNHM, 1 paratype, male, Bálint gen. prep. no. 868); Dep. Amazonas, Chachapoyas, Molinopampa-Granada, 3200 m, 15.XI.2000, leg. B. CALDERON (HNHM, 1 male*); ditto, IX.2002. (MZUJ, 2 males, gen. prep. Jagiello no. 2); Dep. Pasco, La Antena, 2400–2600 m, SE d'Oxapampa, IV.2004, leg. J. BÖTTGER (CPB, 1 male); same, but 2750 m (CPB, 1 female); same, but 29.X.2004 (CPB, 1 male, 1 female).

Timaeta christina ROBBINS et BUSBY, 2008 – ECUADOR (1 male): Prov. Zamora, Zamora-Chinchipe, via Loja, Rio San Francisco, appr. 1800 m, no date, coll. JASIŃSKI (MZUJ, 1 male). PERU (1 female): Dep. Pasco, Oxapampa, La Antena, SE d'Oxapampa, 2700 m, IV.2005, leg. J. BÖTTGER (CPB, 1 female).

Timaeta timaeus (FELDER et FELDER, 1865) JOHNSON, KRUSE et KROENLEIN, 1997 – BOLIVIA (1 male): Prov. Cochabamba, Cochabamba vers Villa Tunari km 90, rio Ronquito, 2250 m, 11.III.2002, leg. P. BOYER (CPB, 1 male). COLOMBIA (4 males): Antioquia, Gualape, II-III, 1962, leg. Ö. APT (1 male); Caldas, El Aquila, 3.III.1996, leg. J. SALAZAR (HNHM, 3 males, gen. prep. nos: 1175, 1176); Caldes, Manizales, 2150 m, 2.IX.1994, leg. Y.A. CALVO (HNHM, 1 female). ECUADOR (18 males): Prov. Napo, Baeza, Horituyacu, 1800 m, 8.VI.1999, leg. T. PYRCZ (MZUJ, 1 male); Prov Napo, Tena, 20.VI.1993, ex coll. A. JASIŃSKY (MZUJ, 2 males); Prov. Morona Santiago, Chiguinda, I.2002, 1750 m (MZUJ, 1 male); Prov. Morona Santiago, N.P. Sangay, via Guamote-Macas, 23.I.2004, 2600 m, leg. J. WOJTUSIAK & T. PYRCZ (MZUJ, 1 male); Prov. Sucumbios, La Bonita 1800 m, II.1997, E. ALDAZ leg. (CPB, 3 males); Prov. Tungurahua, Baños-Viscaya, 2200 m, 3.V.2003, A. MOSER leg. (HNHM, 1 male); Prov. Tungurahua, Machay, 1600 m, 18.XI.1996, P. BOYER leg. (CPB, 1 male); Prov. Tungurahua, Machay, 1500 m, VI.1995, E. ALDAZ leg. (CPB, 1 male); same, but 1600 m, I.1993, E. ALDAZ leg. (CPB, 1 male); same, but 1600 m, IV.1995, E. ALDAZ leg. (CPB, 1 male); same, but 1600 m, VI.1995, E. ALDAZ leg. (CPB, 1 male); Prov. Zamora, Santa Cruz-Nambija, Cordillera de Nanguipa, 1600–2000 m, 30.XI.1998, P. BOYER leg. (CPB, 2 males); Prov. Zamora, Tambo, 1500 m, 20.XI.1996, leg. P. BOYER (CPB, 1 male). PERU (50 males, 11 females): Dep. Amazonas, Cedro de Pirruro, Rodriguez de Mendoza, 2000 m, 4.IV.2002, leg. B. CALDERON (CPB, 3 males); Dep. Amazonas, Chachapoyas, Molinopampa-Granada, 2800 m, IX.2002, leg. B. CALDERON (MZUJ, 1 female); Dep. Amazonas, Environs de Molinopampa, XI.2000, leg. B. CALDERON (CPB, 1 male); Dep. Amazonas, Environs de Rodriguez de Mendoza, I.2001, leg. B. CALDERON (CPB, 1 male); same, but II.2002, leg. B. CALDERON (CPB, 1 male, 1 female); same, but 1400 m, I.2003, leg. B. CALDERON (HNHM, 1 male); Dep. Amazonas, La Sonada, Pomacocha, 1500–3000 m, IX-X.2000, leg. B. CALDERON (CPB, 1 male); Dep. Amazonas, Mendoza-Cedro, 2200–2400 m, 29.VIII.1998, leg. T. PYRCZ (MZUJ, 2 males, HNHM, 1 male); Dep. Amazonas, Mendoza-Hingilpata, 1800 m, 25.IX.1998, leg. T. PYRCZ (HNHM, 1 male); Dep. Amazonas, Mendoza-Llanuayco, 2200–2400 m, 7.IX.1998, leg. T. PYRCZ (MZUJ, 1 male, HNHM, 1 female, Bálint gen. prep. no. 867); same, but 9.IX.1998 (MZUJ, 1 male, 1 female, HNHM, 1 male); same, but 10.IX.1998 (MZUJ, 1 male, HNHM, 2 males); same, but 12.IX.1998 (MZUJ, 2 males); same, but 13.IX.1998 (MZUJ, 4 males; HNHM, 3 males, 1 female, Bálint gen. prep. no. 872, male); same, but 14.X.1998 (HNHM, 2 males); same, but 15.IX.1998 (MZUJ, 1 male); same, but 16.IX.1998 (MZUJ, 2 males, 1 female); same, but 17.IX.1998 (MZUJ, 1 male); Dep. Amazonas, Mendoza-Pirruro, 1800 m, 20.IX.1998, leg. T. PYRCZ (HNHM, 1 male, Bálint gen. prep. no. 871); Dep. Amazonas, Pedro Ruiz Gallo, 1650 m, X.2001, leg. B. CALDERON (CPB, 1 male); same, but II.2002, leg. B. CALDERON (CPB, 1 male, 1 female); Dep. Amazonas, Pomacocha, 2150 m, 13.VI.2000, leg. B. CALDERON (CPB, 2 males); Dep. Amazonas, Pomacochas, 2200–2400 m, VI.2002, leg. B. CALDERON (MZUJ, 1 male, HNHM, 1 male); Dep. Amazonas, Rodriguez de Mendoza, 1400 m, XI.2002, leg. B. CALDERON (HNHM, 1 male); Dep. Amazonas, Rodriguez de Mendoza, 1500–2000 m, XI.1998, don. A. MOSER (HNHM, 1 male); Dep. Amazonas, Rodriguez de Mendoza, 1700 m, IX.2002, leg. B. CALDERON (MZUJ, 6 males); Dep. Amazonas, Rodriguez de Mendoza, 1400 m, II.2003, don. WOJTUSIAK (HNHM, 1 female); Dep. Amazonas, Quebrada Lealnahuayco, 1700 m, II.2005, leg. B. CALDERON (CPB, 1 male);

Dep. Amazonas, [without more data] (MZUJ, 1 female); Dep. Huanuco, Ramosapampa, Huanuco, Panao, 2850 m, 30.VIII.2002, leg. T. PYRCZ (1 male); Dep. Pasco, Ampamayo, Oxapampa, 2200 m, III.2006, leg. J. BÖTTGER (CPB, 1 male); Dep. Pasco, La Antena, SE Oxapampa, 2400–2600 m, 29.X.2004, leg. P. BOYER (CPB, 1 female); Dep. Puno, Carcel Punco, 2600 m, III.2006, leg. J. BÖTTGER (CPB, 1 female); Dep. ?, Yumbatos, VII.2003, leg. J. CHAVEZ (HNHM, male). VENEZUELA (1 female): Merida, La Culata, El Robo, 2300 m, 22.IX.1991, leg. T. PYRCZ (MZUJ, 1 female).

*

Acknowledgements – We would like to express our thanks to Dr OLGA WOŹNICKA (Laboratory for Scanning Electron Microscopy of Biological and Geological Sciences of the Jagiellonian University) for her excellent technical assistance. We also thank to Mr. PIERRE BOYER (Le Puy-Sainte-Réparade, France) and Dr LÁSZLÓ PÉTER BIRÓ (Budapest) for their help and support during the preparation of this study.

REFERENCES

- BÁLINT, Zs. 2010: Microscopic observations and notes on the wing scaling of the genus Annamaria d'Abra and Bálint, 2001 (Lepidoptera: Lycaenidae) – *Lepidoptera Novae* 3: 29–40.
- BÁLINT, Zs., BOYER, P. & WOJTUSIAK, J. 2006: Contributions to the knowledge of Neotropical Lycaenidae: Notes on Abloxurina with the description of five new species (Lepidoptera: Theclinae: Eumaeini). – *Genus* 17: 571–584.
- BÁLINT, Zs. & FAYNEL, C. 2008: Taxonomic notes on the Neotropical hairstreak genus Brangas (Lepidoptera, Lycaenidae) with descriptions of six new species and a new genus. – *Annales historico-naturales Musei nationalis hungarici* 100: 271–306.
- BÁLINT, Zs., KERTÉSZ, K. & WOJTUSIAK, J. 2006: The description of Atlides halljasoni n. sp. from Ecuador and its spectrographic characterization with some notes on the genus (Lepidoptera: Lycaenidae: Eumaeini). – *Genus* 17: 409–415.
- BÁLINT, Zs., MOSER, A., KERTÉSZ, K., BIRÓ, L. P. & PARKER, A. P. 2009: A supposition: structural colours resulting from both natural and sexual selection on an individual wing in the butterfly genus Cyanophrys (Lepidoptera: Lycaenidae) – *Annales historico-naturales Musei nationalis hungarici* 101: 63–79.
- BÁLINT, Zs. & WOJTUSIAK, J. 2000: Jagielo molinopampa gen. et sp. n. from Peru (Lepidoptera: Lycaenidae). – *Annales historico-naturales Musei nationalis hungarici* 92: 183–191.
- BÁLINT, Zs., WOJTUSIAK, J., PISZTER, G., KERTÉSZ, K. & BIRÓ, L. P. 2010: Spectroboard – an instrument for measuring spectral characteristics of butterfly wings – a new tool for taxonomists. – *Genus* 21: 163–168.

- BIRÓ, L. P. & VIGNERON, J. P. 2010: Photonic nanoarchitectures in butterflies and beetles: valuable sources for bioinspiration. – *Laser & Photonic Reviews* **4**: 1–23.
- CLENCH, H. K. 1971: Two new hairstreaks from Mexico (Lepidoptera: Lycaenidae). – *Bulletin of the Allyn Museum* **3**: 1–6.
- D'ABRERA, B. 1995: *Butterflies of the Neotropical Region. Part VII. Lycaenidae.* – Hill House, Black Rock, Victoria, pp. i-xi, 1098–1270.
- DRAUDT, M. 1919–1920: Theclini F. – In: SEITZ, A. (ed.): *Die Gross-Schmetterlinge der Erde, 5. Band. Die Amerikanischen Tagfalter mit 203 Tafeln.* – Alfred Kernen Verlag, Stuttgart, pp. 744–812.
- ELIOT, J. N. 1973: The higher classification of the Lycaenidae (Lepidoptera): a tentative arrangement. – *Bulletin of the British Museum (Natural History), Entomology* **28**: 371–505.
- GOODSON, F. W. 1946: Notes on American Theclinae (Lep. Lycaenidae). – *The Entomologist* **80**: 273–276.
- HALL, J. P. W. & HARVEY, D. J. 2002: A survey of androconial organs in the Riodinidae (Lepidoptera). – *Zoological Journal of the Linnean Society* **136**: 171–197.
- JOHNSON, K., SALAZAR, J. A. & VÉLEZ, J. H. 1997: Nuevas especies de Micandra Staudinger de Colombia, con la diferenciación de Trochusinus, un género nuevo de Eumaeini. – *Revista de Theclinae Colombianos* **15**: 1–15.
- ROBBINS, R. K. 1991: Evolution, comparative morphology, and identification of the eumaeine butterfly genus *Rekoa* Kaye (Lycaenidae: Theclinae). – *Smithsonian Contributions to Zoology* **498**: 1–64.
- ROBBINS, R. K. 2004: Lycaenidae. Theclinae. Tribe Eumaeini. Pp. 118–137. – In: LAMAS, G. (ed.): *Checklist: Part 4A. Hesperioida – Papilioidea.* Association for Tropical Lepidoptera, Scientific Publishers, Gainesville, xxxvi + 439 pp.
- ROBBINS, R. K. & BUSBY, R. C. 2008: Phylogeny, taxonomy, and sympatry of Timaeta (Lycaenidae: Theclinae: Eumaeini): an Andean montane forest endemic. – *Tijdschrift voor Entomologie* **151**: 205–233.
- ROBBINS, R. K. & BUSBY, R. C. 2009: Updated phylogeny, taxonomy, and diversification of *Janthecla* Robbins & Venables (Lycaenidae: Theclinae: Eumaeini). – *Journal of Research on the Lepidoptera* **41**: 5–13.