Genus	Vol. 24(2): 131-141	Wrocław, 31 VII 2013

Systematics, bionomics and zoogeography of high Andean pedaliodines. Part 14: Two new species of *Pedaliodes* Butler from the Huancabamba Deflection in southern Ecaudor and northern Peru (Lepidoptera: Nymphalidae: Satyrinae)

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Abstract. Two new species of the genus *Pedaliodes* Butler are described from the Huancabamba Deflection area along the Peru – Ecuador border, the transitional zone between northern and central Andes, and one of the most diverse faunal regions of montane butterflies of the Neotropical region. *Pedaliodes namballe* n. sp., described from the Tabaconas-Namballe National Sanctuary, is closely related to *P. arturi* Pyrcz & Viloria which occurs allopatrically on the western slopes of the Andes in the same area. *P. garlaczi* n. sp., found in the southern part of the Podocarpus National Park, has no close relatives identified so far. A check-list of the species of the genus *Pedaliodes sensu lato* occurring in Tabaconas-Namballe is given.

Key words: entomology, taxonomy, Andes, butterflies, cloud forest-paramo ecotone, genitalia, new species, *Pedaliodes namballe* n. sp., *Pedaliodes garlaczi* n. sp., Peru, species richness

INTRODUCTION

The Huancabamba Deflection, spreading over southern Ecuador and northern Peru, is one of the most important biogeographic regions of the entire Andes because of its strategic position within the transition zone between northern and central Andes. It is an area of high endemism and high species diversity of Lepidoptera due to faunal overlapping of western-eastern, and northern-southern Andean elements (Pyrcz 2000; Pyrcz et al. in press). Its faunal diversity undoubtedly also derives from the ecological diversity. It is a mosaic of dry Interandean valleys, perhumid montane forests and high elevation paramos.

The studies of the butterfly fauna of the Huancabamba Deflection began over a hundred years ago with the explorations of two Polish naturalists, Konstanty Jelski and Jan Sztolcman (Sztolcman 1912). They collected thousands of specimens, unfortunately most of them destroyed during World War II. At the beginning of the 20th century, the brothers Felix and Charles Pratt collected again in the valley of Huancabamba. Some species were described based on their material only recently, for example the Pronophilina satyrine *Manerebia prattorum* Pyrcz & Willmott (Pyrcz et al. 2006). For most of the last century collecting was restricted to the Ecuadorian part of the Huancabamba Deflection, particularly the Nudo de Sabanillas, the most accessible area situated along the main road across the Andes connecting the main cities of southern Ecuador, Loja and Zamora. Satyrinae were collected and described for example by Brown (1943, 1944). Lepidoptera research intensified from 1980s onwards. As a result, numerous papers concerned mostly with the taxonomy, fauna and ecology of butterflies and moths of the Nudo de Sabanillas in Ecuador were published (Brehm et al. 2003, 2008; Hall & Lamas 2001; Hall & Willmott 2010; Hall et al. 2005; Willmott & Hall 1995; Willmott et al. 2001; Willmott & Lamas 2007; Jasiński 1998). Across the Peruvian border, the valley of Tabaconas has been sampled by Ecuadorian (Ismael Aldaz) and Peruvian (Manuel Tafur) butterfly collectors several times from 1999-2004. In the last three decades the Museum of Natural History of the San Marcos University in Lima organized several short collecting trips to the western slopes of the Cordillera in extreme northern Peru (Lamas 1999, 2004).

Several lepidopterological papers concerned with the butterfly fauna of the Huancabamba Deflection were dedicated to the exclusively montane satyrine subtribe Pronophilina, in particular to the genera *Pedaliodes* Butler *sensu lato* (Pyrcz & Viloria 1999), *Lymanopoda* Westwood and *Daedalma* Hewitson (Pyrcz *et al*. 1999, 2010), *Lasiophila* C. & R. Felder and *Pronophila* Westwood (Pyrcz 1999, 2000). In an attempt to complete the inventory of the butterfly fauna of the Tabaconas-Namballe National Reserve the area has been sampled for the last two years by the second and third authors of this article.

STUDY AREA

There are two protected areas in the Huancabamba deflection area: the Tabaconas-Namballe National Sanctuary (SNTN) and the Podocarpus National Park (PNP). The SNTN is located in the Tabaconas and Namballe districts of the San Ignacio province in the Cajamarca department in extreme northern Peru. It extends over 32 124 ha. The PNP is located in the provinces of Zamora-Chinchipe and Loja in the southern Ecuador. It covers currently 146 280 ha. The climate of SNTN and PNP is characterized by low temperatures, high relative humidity, and rainfall distributed over the year with a maximum between January – April. In the paramos mean humidity is 87%, whereas mean annual rainfall is 1800 mm, varying between 740 and 3442 mm. Main plant communities are montane forests occupying the elevational belt above 2000 m below 3500 m, and paramos generally above 3100 m. The goal of the creation of the SNTN and PNP was the protection of the extreme southern extremity of Andean paramos and

relics of cloud forests, and their fauna. Cloud forests of SNTN and PNP are characterized by high species diversity, notable percentage of endemic species and high turnover along the elevational gradient.

MATERIAL AND METHODS

The following abbreviations and collection acronyms were used:

FW: forewing
HW: hindwing
V: ventral surface
D: dorsal surface
BMNH: Natural History Museum, London, UK (formerly British Museum (Natural History))
MUSM: Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima, Peru
MHN-UNSA: Museo de Historia Natural, Universidad Nacional de San Agustín, Arequipa, Peru
MZUJ: Muzeum Zoologiczne Uniwersytetu Jagiellońskiego, Kraków, Poland.
TWP: collection of Tomasz Wilhelm PYRCZ, Warsaw, Poland (to be integrated into MZUJ)

Type material was examined in BMNH, ZMHB, MUSM and MZUJ. Additional material was examined in BMNH and in other collections. Male genitalia were dissected according to standard procedure, preserved in glycerol, and examined, alongside other morphological microstructures, under a Olympus SZX9 stereomicroscope equipped with Nikon digital camera DS-Fi1 used for taking pictures of the dissections, which were then processed in Combine ZP and Corel Photo-Paint X3 programs to enhance focus and improve quality. Dissections are kept together with the specimens, in glycerol vials pinned under corresponding specimens. Genital terminology follows Razowski (1996). Adults were photographed with an Olympus E-500 digital camera, and colour plates were composed using Adobe PhotoShop version 8 software.

SYSTEMATIC OVERVIEW

Pedaliodes namballe Pyrcz & Cerdeña n. sp.

(Figs. 1A, 2)

Etymology

This species is named after the district of Namballe which gave name to Tabaconas – Namballe National Sanctuary.

Type locality

Sector Lagunas Arrebiatadas, Tabaconas-Namballe, Cajamarca, Peru.

Material examined

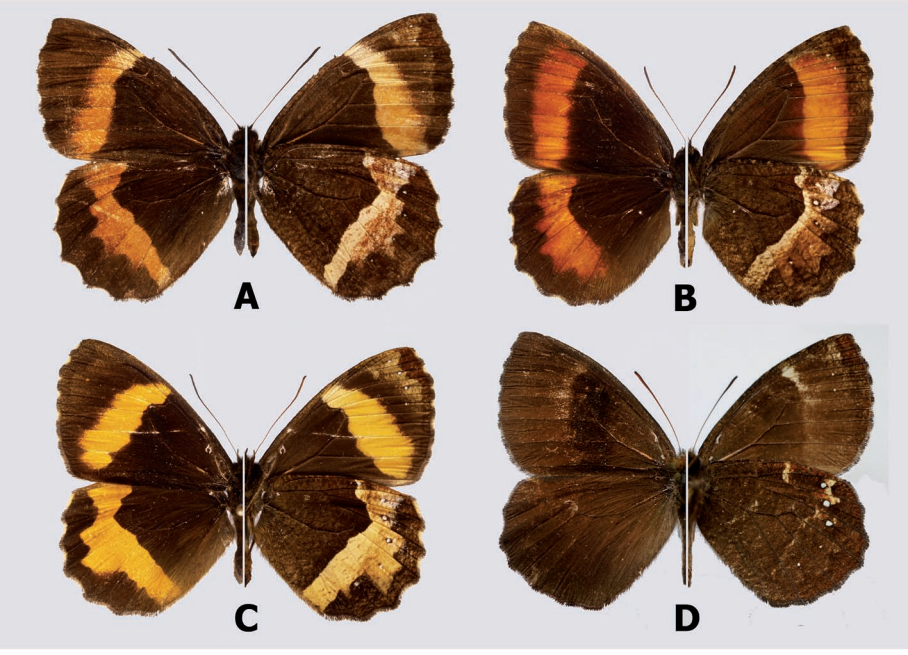
PERU: Holotype male: Cajamarca, Santuario Nacional Tabaconas Namballe, Sector Lagunas Arrebiatadas, 3118 m, 05º14´09¨N/ 79º16´47¨W, 05.X.2009, Erick Huamani leg., MUSM; Paratypes (6 males): 4 males: same data, MHN-UNSA; 2 males: same data (1 male: prep. genit. 01/27.03.2012, J. Lorenc), MZUJ.

Diagnosis

This species shares with several congeners conspicuous median orange bands. Their colour is most similar to that of *P. arturi* Pyrcz & Viloria (1999) (Fig. 1B), which occurs on the western slopes of the Andes in southern Ecuador and northern Peru. However, in *P. arturi* on the FW it is parallel to outer margin whereas in *P. namballe* it is oblique and noticeably bent at vein M3. In this respect it resembles *P. pelinna* (Hewitson) (Fig. 1C) which occurs at lower elevations in SNTN, whose bands are however considerably wider and yoke yellow instead of orange. Other similarly patterned and coloured species are found in central Colombia (*P. thiemei* Staudinger) and southern Peru (*P. amafania* Thieme).

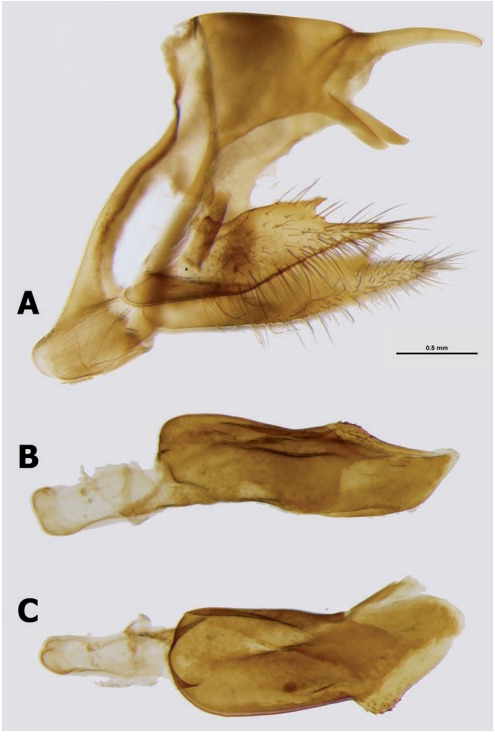
Description

MALE (Fig. 1A): Head: Antennae reaching half length of the costa, slender, naked, dorsally brown, ventrally orange brown, club formed gradually, slightly thicker than



1. Adults (left: dorsal; right: ventral): A – *Pedaliodes namballe* n. sp. male, Paratype; B – *Pedaliodes arturi* male, Paratype, above Jimbura, Loja, Ecuador; C – *Pedaliodes pelinna* male, Tabaconas, Cajamarca, Peru; D – *Pedaliodes garlaczi* n. sp. male, Holotype, Cerro Toledo, Ecuador

shaft, composed of 11 segments, dark brown. Eyes chocolate brown with black patches, lustrous, covered with dense, black hair. Labial palpi two times as long as the head, covered with dark brown, chestnut and yellow hairy scales, ventrally long, laterally and dorsally short. Frons with a tuft of long, black and yellow hair. Thorax: Dorsally black, patagium, tegulae and prothorax covered with long, black and yellow hairy scales, otherwise mostly naked; ventrally brown; legs brown, tibiae covered with black and yellow hair, femora and tarsi with brown and sparse yellow scales, tarsi with numerous blackish, short spines. Abdomen: Black, basal segments hairy, dorsally mostly naked covered with short, and sparse black hairy scales, denser laterally, ventrally covered with dense chestnut and yellow scales. Wings: Forewing (length: 26-27.5 mm, mean: 26.8 mm, n=6) apex acute, outer margin straight, except for being slightly truncated below apex. HW oval with a gently undulated outer margin. FWD dull, dark brown in median half, medium brown in outer half with a dark orange brown dusted postmedian band of approximately similar width throughout, 4-5 mm, with a sharp inner and diffused outer edge, from costal margin to tornus, bent at a shallow angle from vein M3 to costa, a darker brown, faint submarginal line parallel to outer margin; fringes alternately brown and milky white in the interveins; androconial patch broken into two parts, an irregular triangle penetrating discal cell from root of vein M2 to Cu2 and extending



2. Male genitalia of *Pedaliodes namballe*: A – lateral view; B – aedeagus in lateral view; C – aedeagus in dorsal view

to inner edge of orange band, and oval along vein 1A. HWD lustrous dark brown in basal half, dull medium brown in outer one third, with a wide dark orange band with a sharp inner edge bent at straight angle at vein M2, and a sinuate, slightly diffused outer edge, some 6 mm at costa, then narrowing to some 3 mm at vein M2, widening again towards veins Cu1 and Cu2 and then narrowing gradually to anal margin near tornus; fringes mostly milky white except for dark brown at vein tips. FWV colour pattern reflected from the upperside except that slightly lighter and paler, especially the orange band, a well-defined chocolate brown area from submarginal area to outer margin, some 2mm wide, subapical area dusted with pale yellow scales, a row of five minute subapical white dots from R4-R5 to M3-Cu1. HWV colour pattern reflected from the upperside, basal two-thirds chocolate brown dusted with some fine ripple-like pattern made of dark brown and light brown scales, postmedian band pale yellow suffused with brown scales progressively towards its outer edge, a row of five minute submarginal white dots from M1-M2 to Cu2-1A, marginal area slightly suffused with light brown scales. Male genitalia (Fig. 2): Dorsum of tegument flat, uncus slender, gently arched, approximately ¾ the length of tegumen dorsum, subunci prominent, approximately 2/3 the length of uncus, pedunculus small, valvae roughly the length of tegumen+uncus, with one sharply ended dorsal process aligned with the long, pointed distal extremity; saccus wide and moderately long, aedeagus as long as saccus+valve, massive, flattened dorso ventrally, proximal opening 1/3 the length of the entire aedeagus, much narrower than the remaining part of it, with a lateral serrate crest, and a sharp apical extremity.

FEMALE: So far unknown.

Pedaliodes garlaczi Pyrcz & Cerdeña n. sp.

(Figs. 1E, 3)

Etymology

This species is dedicated to dr. Rafał Garlacz, an entomologist from the Zoological Museum of the Jagiellonian University who participated in the expedition to southern Ecuador in 2004 during which this new species was collected, in recognition of his valuable contribution to the studies of Neotropical Lepidoptera.

Type locality

Cerro Toledo, Podocarpus National Park, Loja Province, Ecuador

Material examined

ECUADOR: Holotype male: Loja Province, Podocarpus National Park, Cerro Toledo, 3100-3150 m, 14.IX.2004, T. Pyrcz leg., MZUJ; Paratype (male): same data, prep. genit. 04/24.08.2012, J. Lorenc, MZUJ.

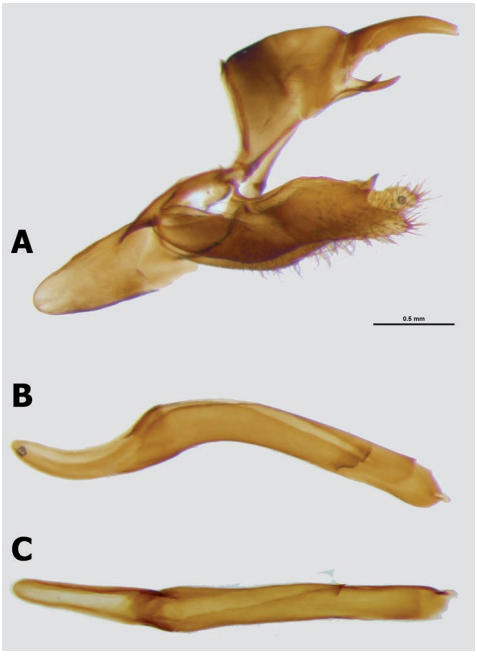
Diagnosis

This species can be distinguished from several nearly all brown congeners by the large FWD androconial patch darker than the ground colour with a conspicuous

lighter distal edge, and the series of three submarginal HWV rounded dots in Rs-M1 to M2-M3.

Description

MALE (Fig. 1E): Head: Antennae reaching half length of the costa, slender, naked, dorsally brown, ventrally orange brown, club formed gradually, slightly thicker than shaft, composed of 11 segments. Eyes chocolate brown with black patches, lustrous, covered with long and dense, black hair. Labial palpi two times as long as the head, covered with dark brown and black hairy scales, ventrally long, laterally and dorsally short, and lateral milky white scales. Frons with a tuft of rather short, compared to *P. namballe*, blackish-brown hair. Thorax: Dorsally black, patagium, tegulae and prothorax laterally covered with russet and yellow-greenish long hair, otherwise mostly naked; ventrally brown; legs brown, tibiae covered with brown and sandy yellow hair, femora and tarsi brown, tarsi with numerous blackish, short spines. Abdomen: Black, basal segments hairy, dorsally mostly naked covered with short, and sparse black hairy scales, denser laterally, ventrally covered with dense chestnut and yellow scales. Wings: FW (length: 25 mm, n=2) apex acute, outer margin concave. HW rounded with a gently undulated outer margin. FWD lustrous dark brown, with a large, roughly rectangular, blackish-brown median androconial patch extending from costa to anal margin, with a lighter, pale brown, distal edging, more prominent in postdiscal area; faint intravenal



4. Male genitalia of *Pedaliodes garlaczi*: A – lateral view; B – aedeagus in lateral view; C – aedeagus in dorsal view

darker brown stripes; fringes blackish-brown and white in the interveins. HWD uniform dark brown, a shade darker than the FW, hairy in basal one-third and along anal margin; fringes blackish brown, whitish in the interveins from apex to M2. FWV dull brown, a well-defined milky white post-discal streak extending from costa towards wing median area, gradually fading away; three minute subapical white dots from R4-R5 to M1-M2; subapical and apical area dusted with white; an irregular submarginal chocolate brown line. HWV dark brown, sparsely rippled with milky white scales, somewhat denser along postdiscal line where forming a narrow milky white apical streak extending to Rs, and diffuse patch in apical area; a series of six submarginal white dots, three of which in Rs-M1 to M2-M3 conspicuous, and the remaining three from M3-Cu1 to Cu-1A minute. Male genitalia (Fig. 3): Dorsum of tegumen flat, uncus stout, gently arched, the same length as dorsum of tegumen, subunci thin, approximately 1/3 the length of uncus, pedunculus small, valvae roughly the length of tegumen+uncus, with one sharply ended dorsal process pointing upwards, and with blunt distal extremity; saccus very wide and deep, aedeagus as long as saccus+valve, thin, fusiform, of approximately similar width throughout, not contorted, s-shaped dorso-ventrally, proximal opening 1/3 the length of the entire aedeagus, no apical crest, a pointed apical extremity.

FEMALE: So far unknown.

DISCUSSION

Male genitalia and colour pattern indicate that *Pedaliodes namballe* belongs to a possibly monophyletic group of species occurring in the northern Andes, most of which characterized by conspicuous yellow or orange dorsal markings (Pyrcz & Viloria 2009). Two other species of this group are found in the Huancabamba Deflection: *P. arturi* occurring on the western slopes of the Andes in extreme southern Ecuador and northern Peru, and *P. pelinna* in SNTN and farther north on the eastern slopes of the Andes in southern Ecuador. The three species are similar in ecological terms. They all occur in high elevation forests near timberline. *P. pelinna* has however a much wider elevational range being found from 2600-3200 m, and in SNTN it appears to replace parapatrically *P. namballe* at lower elevations. *P. arturi* is restricted to a narrow band above 3000 m. All known specimens of *P. namballe* were also collected above 3000 m in a forest formation dominated by *Clusia* spp. in the vicinity of open grassy paramo with some sparse trees. No clear-cut synapomorphies indicating a closer affinity with either of the two north Peruvian congeners could be identified. It appears that the SNTN is the southernmost distribution limit of this species-rich group of *Pedaliodes*. Other orange-banded species occurring south of the Chamaya valley in the Chachapoyas area in Peru (Amazonas), *P. peruda* (Hewitson) and *P. maruda* Pyrcz, belong to another group of *Pedaliodes* as indicated by consistently different male genital morphological characters (Pyrcz 2004; Pyrcz *et al*. 2008).

P. garlaczi is assigned to the genus *Pedaliodes sensu stricto* despite some atypical characters of its male genitalia. In particular, the aedeagus is long, uncontorted, and arched, and closely resembles the aedeagi of the species of *Panyapedaliodes* Forster. In this respect it is also similar to *Pedaliodes kruegeri* (Pyrcz) which has been originally

assigned to the genus *Altopedaliodes* and found in northern Ecuador and Colombia, and to *Pedaliodes halli* Pyrcz, sympatric in PNP (Pyrcz 2004b). However, the valvae of *P. garlaczi* are typical of *Pedaliodes sensu stricto*, with a single, sharp dorsal process, contrary to the smooth valvae of *P. halli*. Moreover, *P. garlaczi* has a large FWD androconial patch of similar shape and position as in most species of *Pedaliodes sensu stricto*. In *Altopedaliodes* the androconial patch is either very small or absent, whereas in *Panypapedaliodes* it is not apparent. The validity of *Altopedaliodes* was questioned in several papers, and it has not been demonstrated convincingly so far that it is a monophyletic entity (Padrón, in prep.).

This study confirms the area of Tabaconas Namballe and Podocarpus National Park in the Huancabamba Deflection an important centre of endemism of butterflies, and of montane Satyrinae in particular. Numerous species and subspecies of Pronophilina were described from this region. In consequence of more thorough sampling in northern Peru and southern Ecuador some of them appeared to have somewhat wider distributions, and are not strictly endemic of the Huancabamba Deflection. For example, *Pronophila attali* Pyrcz (Pyrcz 1999) was found in the Chachapoyas area (Pyrcz 2004a), *Pedaliodes arturi* was detected on the western slopes of the Andes in Lambayeque (Pyrcz, unpubl.), and *Pedaliodes tabaconas* Pyrcz & Viloria was collected east of Cuenca in south-central Ecuador (Pyrcz, unpubl.). Nonetheless, several other species Pronophilina seem to be confined to the Huancabamba Deflection, including *Pronophila margarita* Pyrcz (Pyrcz 1999), *Altopedaliodes kurti* Pyrcz & Viloria (Pyrcz et al. 1999), *Pedaliodes puciula* Pyrcz & Viloria (Pyrcz & Viloria 2006) and *Pedaliodes halli* Pyrcz (Pyrcz 2004). There are also numerous endemic subspecies found in this region, some of which listed herein (Appendix) were identified as new but not described as yet due to insufficient comparison material.

Appendix 1.

Species of *Pedaliodes sensu lato* occurring in the Tabaconas-Namballe National Sanctuary

1. *Altopedaliodes perita sorda* Pyrcz, 2004
2. *Altopedaliodes zsolti zsolti* Pyrcz & Viloria, 1999
3. *Altopedaliodes kurti* Pyrcz & Viloria, 1999
4. *Altopedaliodes flavopunctata* ssp. (Staudinger, 1894)
5. *Pherepedaliodes naevia* (Thieme, 1905)
6. *Pherepedaliodes nubilia* Pyrcz & Viloria, 1999
7. *Panyapedaliodes drymaea drymaea* (Hewitson, [1858])
8. *Panyapedaliodes muscosa muscosa* (Thieme, 1905)
9. *Panyapedaliodes phila* ssp. (Hewitson, 1862)
10. *Panyapedaliodes tomentosa* (Weymer, 1911)
11. *Panyapedaliodes traceyannae* Pyrcz & Viloria, 1999
12. *Pedaliodes asconia* ssp. Thieme, 1905

13. *Pedaliodes balnearia* Pyrcz &Viloria, 1999
14. *Pedaliodes spina bifurcata* Pyrcz, 2006
15. *Pedaliodes transmontana* Pyrcz & Viloria, 1999
16. *Pedaliodes luperca* Thieme, 1905
17. *Pedaliodes manis* ssp. (C. & R. Felder, [1867])
18. *Pedaliodes montagna montagna* Adams & Bernard, 1981
19. *Pedaliodes petri petri* Pyrcz & Viloria, 1999
20. *Pedaliodes phaedra phaedra* (Hewitson, 1870)
21. *Pedaliodes pheretias* (Hewitson, 1872)
22. *Pedaliodes phrasicla rufa* Pyrcz, 2004
23. *Pedaliodes cf. pisonia* (Hewitson, 1862)
24. *Pedaliodes poesia* (Hewitson, 1862)
25. *Pedaliodes polusa* ssp. (Hewitson, 1862)
26. *Pedaliodes pomponia* (Hewitson, 1869)
27. *Pedaliodes porcia pallantias* (Hewitson, 1873)
28. *Pedaliodes praemontagna* Viloria & Pyrcz, 2008
29. *Pedaliodes puciula* Pyrcz & Viloria, 2006
30. *Pedaliodes praxithea* (Hewitson, 1870)
31. *Pedaliodes dracula* ssp. Pyrcz & Viloria, 1999
32. *Pedaliodes tabaconas* Pyrcz & Viloria, 1999
33. *Pedaliodes halli* Pyrcz, 20004
34. *Pedaliodes pelinna* (Hewitson, 1870)
35. *Pedaliodes namballe* Pyrcz & Cerdeña, n. sp.
36. *Neopedaliodes entella* (Thieme, 1905)
37. *Neopedaliodes parrhoebia parrhoebia* (Hewitson, 1872)
38. *Neopedaliodes phoenicusa* (Hewitson, 1868)
39. *Corderopedaliodes corderoi corderoi* (Dognin, 1893)

Acknowledgements

The authors would like to thank Jadwiga Lorenc Brudecka (MZUJ, Kraków) for helping with genital preparations and microscopic photography, and Keith Willmott (Gainesville) for additional data. The research trips by TW to Ecuador was supported by a internal grant of the Jagiellonian University CR/BW/UJ/MZ/2004. This article is an outcome of a scientific cooperation agreement between the Zoological Museum of the Jagiellonian University in Kraków and the Natural History Museum of the San Agustín University in Arequipa.

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