

PERSICARIA NEPALENSIS (POLYGONACEAE), A NEW POTENTIALLY INVASIVE ANTHROPOPHYTE IN THE POLISH FLORA

TOMASZ KOWALCZYK¹, ARTUR PLISZKO & SZYMON M. DROBNIAK

Abstract. *Persicaria nepalensis* (L.) Mill. is an annual herb occurring natively in South, East and Southeast Asia, having a range extending from Oceania to East Africa. Here we report the first Polish stand of this species, found in 2011 near Baligród (Western Bieszczady Mountains), followed by the discovery of two more stands in the surrounding area up to 2013. The floristic composition of vegetation impacted by *P. nepalensis* is presented, and the invasive potential and pathways of introduction of the species are briefly discussed.

Key words: alien species, Bieszczady Mts, Carpathians, distribution, *Persicaria nepalensis*, Poland

Tomasz Kowalczyk & Artur Pliszko, Institute of Botany, Jagiellonian University, M. Kopernika 27, Kraków 31-501, Poland; e-mail: tomasz.kowalczyk@uj.edu.pl

Szymon M. Drobniak, Institute of Environmental Science, Jagiellonian University, Gronostajowa 7, Kraków 30-387, Poland, and Anthropological Institute and Museum, University of Zurich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland

INTRODUCTION

Persicaria (L.) Mill. (Polygonaceae) is one of the species-richest genera in the alien flora of Europe, especially in the southern part of the continent (Lambdon *et al.* 2008). Some of its species are distant intercontinental introductions, such as *P. pennsylvanica* (L.) M. Gómez transferred from North America (Kubát & Jehlík 2003) and *P. capitata* (Buch.-Ham. *ex* D. Don) H. Gross originating from South Asia (Nogueira *et al.* 2006).

In Poland the genus *Persicaria* is represented by three anthropophytes. Two of them are considered ephemerophytes [*P. bungeana* (Turcz.) Nakai, *P. orientalis* (L.) Spach.]. *Persicaria walichii* Greuter & Burdet is classified as an invasive kenophyte (Mirek *et al.* 2002; Bartoszek *et al.* 2006; Tokarska-Guzik *et al.* 2012).

During a floristic study in the Western Bieszczady Mountains in 2011 a population of *Persicaria nepalensis* (Meisn.) H. Gross, a species new both to the Polish flora and to the flora of the Carpathians, was discovered.

MATERIALS AND METHODS

Persicaria nepalensis was discovered during floristic surveys done in 2011–2013 in the Pogórze Leskie foothills and in the northern part of the Western Bieszczady Mts (Eastern Carpathians). The researched area is bounded by the San River to the north, the Oslawa River to the west, the road between Rzepedź and Wołkowyja to the south, and the western shores of the Solina Reservoir to the east (Fig. 1). In each of the three *P. nepalensis* stands discovered we made a relevé following the Braun-Blanquet method as modified by Dzwonko (2007). The floristic relevés of the *P. nepalensis* habitats studied are given in Table 1. *Persicaria nepalensis* specimens were collected from each discovered location. Specimens are deposited in the Herbarium of the Institute of Botany of the Jagiellonian University in Kraków (KRA).

RESULTS

***Persicaria nepalensis* (Meisn.) H. Gross**

Bot. Jahrb. Syst. **49**: 277. 1913. – *Polygonum nepalense* Meisn., Monogr. Gen. Polyg.: 84. 1826.

Erect, ascending or decumbent annual, 15–50 cm high. Stem usually branched, rooting at lower

¹ Corresponding author

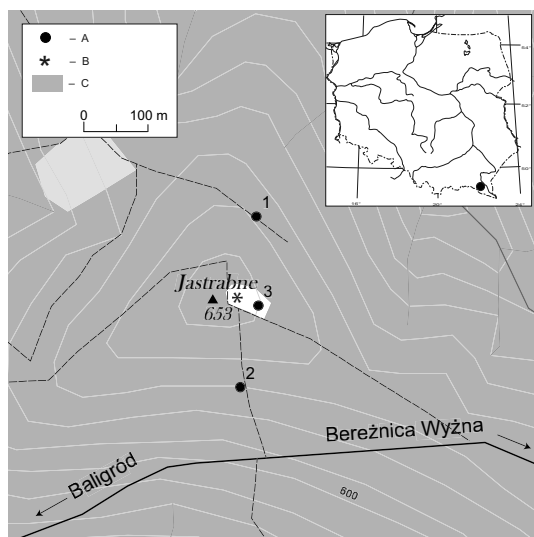


Fig. 1. Stands of *Persicaria nepalensis* (Meisn.) H. Gross in Poland. A – stands of *P. nepalensis*, B – raised blind, C – forests.

nodes, round, glabrous except for whitish glandular trichomes on upper parts of internodes. Leaves alternate, $1.4\text{--}5.0 \times 1.0\text{--}3.0$ cm; heterophyllous: lower leaves broadly ovate or rhomboid with truncate base, petiolate, petiole 2–3 cm long, slightly to moderately winged; upper leaves oblanceolate, subsessile or subamplexicaul with auricled base. Lamina with entire and slightly scabrous margin, revolute, undulate, glabrous on adaxial surface, pubescent on veins and punctate with yellow glands on abaxial surface, apex acute (Fig. 2a–c). Ochreae tubular, truncate, 5–10 mm long, strigose proximally, brownish. Inflorescences terminal and axillary corymbose heads, 6–7 mm in diameter, subtended by sessile, subamplexicaul, ovate to lanceolate leaves ($6.5\text{--}12.5 \times 2.5\text{--}5.0$ mm), peduncles 1–20 mm long, erect with glandular hairs below heads. Ochreolae ovate-lanceolate, acute, $3\text{--}5 \times 2$ mm. Flowers $2.5\text{--}4.0 \times 1.0\text{--}2.0$ mm, shortly pedicellate. Tepals 4(–5), $2.9\text{--}3.5 \times 0.6\text{--}1.5$ mm, obtuse, obovate, usually pink, sometimes white or lavender. Stamens 5(–8), filaments 0.5–1.5 mm long, anthers black-purple, elliptic, ovary biconvex or trigonous with 2(–3) unequal styles, stigmas capitate. Fruit (nut) biconvex or trigonous, $1.0\text{--}2.0 \times 1.0\text{--}1.9$ mm, dull, shining, densely and minutely pitted, light or dark brown to black,

enclosed in perianth (Fig. 2d). Flowering in June–September.

Description follows Qaiser (2001), Li *et al.* (2003), Hinds and Freeman (2005) and Yasmin (2009), modified following our own observations.

Persicaria nepalensis is sometimes confused with the closely related *P. runcinata* (Buch.-Ham. ex D. Don) H. Gross and *P. capitata* (Buch.-Ham. ex D. Don) H. Gross of the same section *Cephalophilon*, mainly due to their capitate inflorescences and truncate ochreas (Kim & Donoghue 2008; Galasso *et al.* 2009).

GENERAL DISTRIBUTION AND ECOLOGY

Persicaria nepalensis is a paleotropical species. Its native geographical range span tropical and subtropical mountain regions of South, East and South-east Asia, reaching Oceania and East Africa. In Asia it has been reported from India, Pakistan, Afghanistan, Nepal, Bhutan, Ceylon, Thailand, the Philippines, Malaysia, Indonesia, China, Japan, South Korea and Russia (Qaiser 2001; Li *et al.* 2003; Nogueira *et al.* 2006). It was also found in Papua-New Guinea (Oceania) (Li *et al.* 2003), Kenya, Ethiopia, Tanzania, Uganda, Zambia and Malawi (Africa) (Nogueira *et al.* 2006). Outside its native range, *P. nepalensis* is occasionally introduced accidentally to other regions. In favorable conditions it readily colonizes, sometimes exhibiting expansive or even invasive tendencies. *Persicaria nepalensis* was introduced accidentally to the Asian part of Turkey (Tan & Baytop 1995) and also to Europe and both Americas. In Europe it is an established anthropophyte in Italy (Pignatti-Wikus 1973, Webb *et al.* 1993), Great Britain (Stace 2010), Germany (Dieckjobst 1994; Brandes 1995; Aboling 2008) and most likely also Belgium (Verloove 2013). It has been reported from the USA and Canada (Hinds & Freeman 2005) and Mexico (Vibrans & Hanan-Alipi 2008). In South America it has been found in Ecuador (Jørgensen & León-Yáñez 1999), Colombia and Venezuela (Meier 2006).

Persicaria nepalensis prefers mountain slopes and river valleys, and is usually found in humid, partially shaded locations, mainly along muddy, gravelly and stony banks of mountain streams and

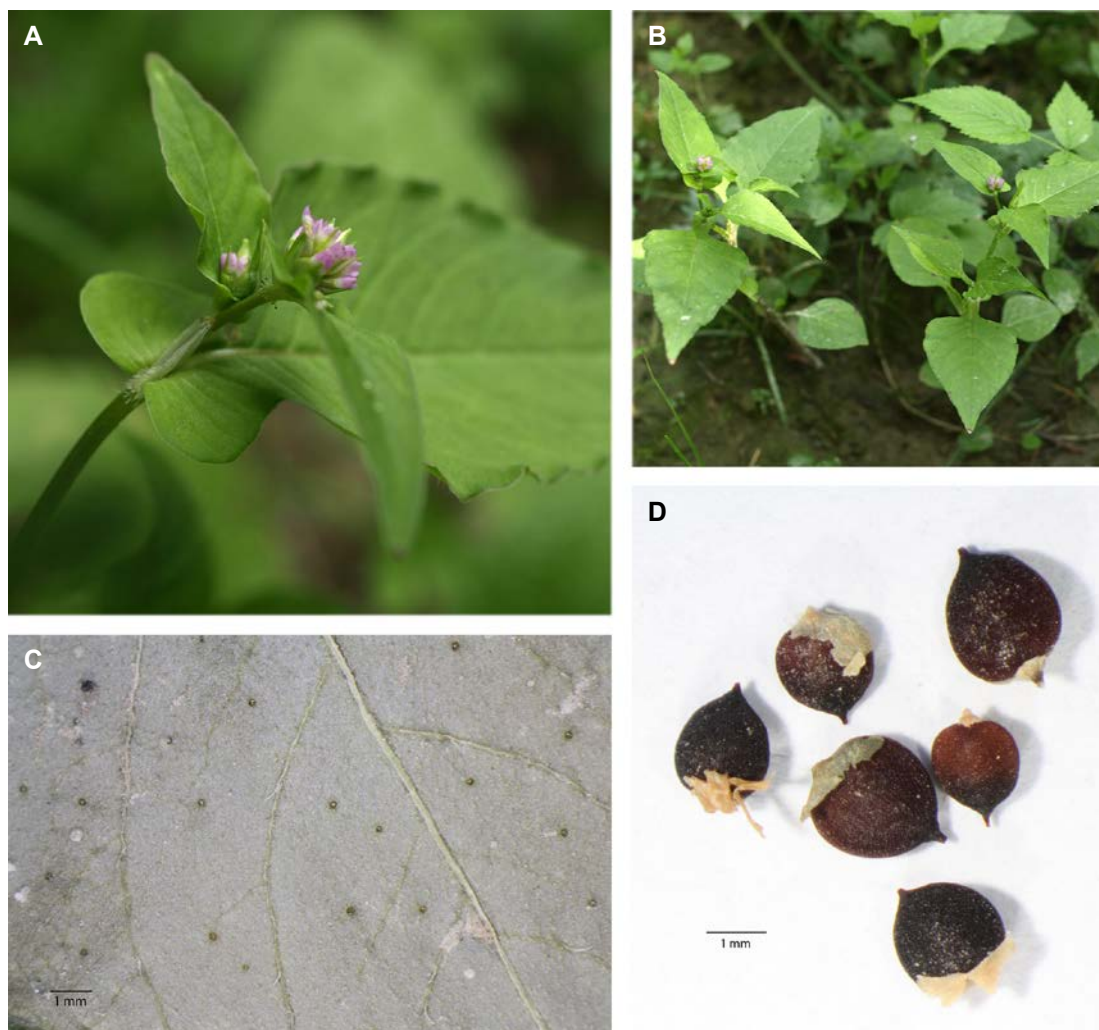


Fig. 2. *Persicaria nepalensis* (Meisn.) H. Gross. A & B – plant's habit in the field, C – abaxial surface of leaf lamina with glands, D – fruits.

along forest edges. Depending on the geographic location its altitude tolerance ranges from 200 to 4000 m a.s.l. (e.g., Qaiser 2001; Li *et al.* 2003). Since *P. nepalensis* is an annual herb exhibiting rapid growth, a high reproductive rate and high fertility, it is relatively resistant to disturbances in its environment. Within its natural range it often becomes an apophyte, spreading to various human-transformed habitats such as forest felling areas, fields, gardens, banks of artificial canals, roadsides and landfills.

OCCURRENCE IN POLAND

The first stand of *P. nepalensis* was found in August 2011, 2 km east of Baligród in the Western Bieszczady Mountains. In July 2013 the first stand was confirmed and two more were found. All three stands are located within a few hundred meters of each other (Fig. 1). *Persicaria nepalensis* grew on rarely used, partly overgrown forest paths. The canopy of the first stand (no. 1 in Fig. 1) is dominated by *Picea abies*, *Fraxinus excelsior*, *Acer*

Table 1. Floristic relevés of the studied *Persicaria nepalensis* (Meisn.) H. Gross. habitats.

No. of relevé	1	2	3
Location	Baligród	Baligród	Baligród
Latitude [N]	49°20'21,1"	49°20'12,2"	49°20'15,7"
Longitude [E]	22°19'12,1"	22°19'10,1"	22°19'09,9"
Date	9.07.2013	9.07.2013	27.07.2013
Area of relevé [m ²]	5	14	25
Plant cover [%]	50	40	95
Slope [°]	10	30	5
Exposition	NE	S	E
No. of species	27	33	27
<i>Persicaria nepalensis</i>	+	1	4
<i>Achillea millefolium</i> L.	.	+	+
<i>Agrimonia eupatoria</i> L.	.	+	.
<i>Agrostis capillaris</i> L.	.	.	+
<i>Agrostis stolonifera</i> L.	+	.	.
<i>Anthemis arvensis</i> L.	.	+	1
<i>Athyrium filix-femina</i> (L.) Roth	+	.	.
<i>Bidens frondosa</i> L.	.	.	+
<i>Callitriche cophocarpa</i> Sendtn.	+	.	.
<i>Carex remota</i> L.	+	.	.
<i>Carex sylvatica</i> Huds.	+	+	.
<i>Centaurea cyanus</i> L.	.	.	+
<i>Centaurea jacea</i> L.	.	+	.
<i>Cerastium</i> sp.	+	.	.
<i>Cirsium arvense</i> (L.) Scop.	.	+	1
<i>Echinochloa crus-galli</i> (L.) P. Beauv.	.	.	+
<i>Elymus repens</i> (L.) Gould.	.	+	2
<i>Euphorbia serrulata</i> Thuill.	.	+	.
<i>Galeopsis tetrahit</i> L.	.	.	+
<i>Galinsoga ciliata</i> (Raf.) S. F. Blake	.	.	1
<i>Geranium</i> sp.	.	+	.
<i>Glechoma hederacea</i> L.	+	.	.
<i>Glyceria notata</i> Chevall.	+	+	.
<i>Hepatica nobilis</i> Schreb.	r	.	.
<i>Holcus mollis</i> L.	.	.	+
<i>Hypericum humifusum</i> L.	.	+	.
<i>Hypericum maculatum</i> Crantz	.	+	+
<i>Impatiens parviflora</i> DC.	2	+	.
<i>Juncus effuses</i> L.	+	+	.
<i>Juncus tenuis</i> Willd.	.	+	.
<i>Lapsana communis</i> L.	.	+	.
<i>Medicago lupulina</i> L.	.	+	.
<i>Mentha arvensis</i> L.	.	+	1
<i>Millium effusum</i> L.	+	.	.
<i>Myosotis sylvatica</i> Ehrh. ex Hoffm.	+	.	.
<i>Oxalis acetosella</i> L.	+	.	.
<i>Polygonum hydropiper</i> L.	1	+	.
<i>Polygonum lapathifolium</i> L.	.	.	+
<i>Phleum pretense</i> L.	.	+	.

Table 1. Continued.

No. of relevé	1	2	3
<i>Plantago major</i> L.	+	1	.
<i>Poa annua</i> L.	.	+	.
<i>Poa palustris</i> L.	.	+	.
<i>Prunella vulgaris</i> Huds.	+	1	.
<i>Ranunculus repens</i> L.	1	+	.
<i>Raphanus raphanistrum</i> L.	.	.	+
<i>Rumex obtusifolius</i> L.	2	1	.
<i>Senecio nemorensis</i> agg.	+	.	.
<i>Spergula arvensis</i> L.	.	.	2
<i>Stachys palustris</i> L.	.	.	2
<i>Stachys sylvatica</i> L.	+	.	.
<i>Stellaria graminea</i> L.	.	+	.
<i>Trifolium aureum</i> Pollich	.	+	.
<i>Trifolium pretense</i> L.	.	+	.
<i>Trifolium repens</i> L.	.	+	.
<i>Tussilago farfara</i> L.	+	+	.
<i>Veronica filiformis</i> Sm.	.	+	.
CULTIVATED PLANTS			
<i>Avena sativa</i> L.	.	.	1
<i>Brassica napus</i> L.	.	.	+
<i>Helianthus tuberosus</i> L.	.	.	+
<i>Pisum sativum</i> L.	.	.	+
<i>Solanum tuberosum</i> L.	.	.	+
<i>Triticum aestivum</i> L.	.	.	+
<i>Vicia faba</i> L.	.	.	+
<i>Vicia sativa</i> L.	.	.	+
<i>Zea mays</i> L.	.	.	+

pseudoplatanus, *Abies alba* and *Fagus sylvatica*; the second stand (no. 2) is dominated by *Larix decidua*, *Picea abies* and *Sambucus nigra*. The third stand (no. 3) is a small field where vegetables are cultivated to be used as bait for game, near a raised blind. *Persicaria nepalensis* is clearly spreading from this location, following along a forest road. The first two stands comprise ca 15 individual plants; in the third one we noted ca 20,000 plants.

1. Baligród – rarely used forest path, 49°20'21.1"N/22°19'12.1"E, alt. 641 m, 14 Aug. 2011, leg. T. Kowalczyk.

2. Baligród – rarely used forest path, 49°20'12.2"N/22°19'10.1"E, alt. 626 m, 9 July 2013, leg. Sz. Drobniak & T. Kowalczyk.

3. Baligród – small field at a raised blind, 49°20'15.7"N/22°19'09.9"E, alt. 647 m, 27 July 2013, leg. T. Kowalczyk & A. Pliszko.

Table 1 presents the relevés taken from the recorded *P. nepalensis* stands.

DISCUSSION

Persicaria nepalensis occurs in Poland in human-transformed habitats. From the distribution of the discovered stands and the numbers of individual plants in the respective locations we can infer both the probable origin of these plants and the potential pathways of further expansion of the species. Since the density of the plants was highest at the third location (75% of the projective coverage in the relevé), the raised blind and the small field directly adjacent to it are the most likely points of origin, from where the plant began to expand its range along the road at the east side of the field. *Persicaria nepalensis* seeds probably were

accidentally transferred to the field with sowing material used to grow cultivated species. The other two stands along forest paths have much lower densities of *P. nepalensis*, which suggests their secondary origin. Although impurities in sowing material are the most likely source of seeds of this species, other explanations cannot be ruled out at this stage. The *P. nepalensis* seeds may have been brought to the studied area accidentally by tourists. Finally, the *P. nepalensis* seeds may have been transferred with seeds of other plants used as bird food – this mode of transport had already been suggested in the case of the German populations of this species (Diekjobst 1994; Aboling 2008). The much higher density of *P. nepalensis* at the third stand may also be attributable to more favorable conditions at that site.

Irrespective of the origin of *P. nepalensis* in our flora, the discovery of this species offers a rare opportunity to observe the expansion of a potentially invasive species in Poland. *Persicaria nepalensis* most likely arrived in the studied area recently and spread quickly from its original location. Its wide range of ecological tolerance suggests that it may quickly spread to new habitats. In other countries the expansion of *P. nepalensis* (especially into human-transformed habitats) has already caused serious problems. In both Americas it has been classified as an invasive species (Meier 2006; Vibrans & Hanan-Alipi 2008). In Asia it significantly affects the tea crop and in Africa it is one of the most common and most aggressive weeds, substantially decreasing the yields of wheat, coffee and other cultivated plants (Gebre *et al.* 1988; Nimje 1988; Njoroge 1994; Kefyalew *et al.* 2000; Roder *et al.* 2009; Asres & Das 2011; Li *et al.* 2012).

In the near future the further expansion of *P. nepalensis* in the studied area along roads and forest paths should be expected. Given the potential threats to the economy and nature associated with the expansion of this species, we suggest that the *P. nepalensis* population requires monitoring as well as measures to contain its expansion. Possible steps include controlling the seed material used by hunters, and mowing existing stands of *P. nepalensis*, preferably before flowering.

ACKNOWLEDGEMENTS. We are grateful to the anonymous reviewers for helpful remarks and suggestions on the manuscript. This project was financed by the National Science Center (no. DEC–2012/07/N/NZ8/00117).

REFERENCES

- ABOLING S. 2008. *Persicaria nepalensis* (Meisn.) H. Gross – Erstnachweis für Niedersachsen. *Floristische Rundbriefe* **41**: 33–38.
- ASRES B. & DAS T. K. 2011. Diversity and integrated management of weeds in highland wheat of Northern Ethiopia. *Plant Protection Quarterly* **26**(1): 8–16.
- BARTOSZEK W., URBISZ A. & TOKARSKA-GUZIŁ B. 2006. *Polygonum polystachyum* Wall. ex Meissner in Poland: status, distribution, habitats. *Biodivers. Res. Conservation* **1–2**: 86–88.
- BRANDES D. 1995. Die Uferflora im Bereich des Lago Maggiore. *Floristische Rundbriefe* **29**(2): 194–197.
- DIEKJOBST H. 1994. Der nepalesische Knöterich (*Polygonum nepalense* Meisn.), ein Neufund in Deutschland. *Floristische Rundbriefe* **27**(2): 90–93.
- DZWONKO Z. 2007. Przewodnik do badań fitosocjologicznych. Instytut Botaniki Uniwersytetu Jagiellońskiego & Sorus, Kraków – Poznań.
- GALASSO G., BANFI E., DE MATTIA F., GRASSI F., SGORBATI S. & LABRA M. 2009. Molecular phylogeny of *Polygonum* L. s.l. (Polygonaceae), focusing on European taxa: preliminary results and systematic considerations based on *rbcL* plastidial sequence data. *Atti Soc. Ital. Sci. Nat. Mus. Civico Storia Nat.* **150**(1): 113–148.
- GBEBRE H., TAREKEGNE A. & ASMARE E. 1988. Preliminary indications on the importance of yield limiting factors on wheat. In: M. VAN GINKEL & D. TANNER (eds), *The Fifth Regional Wheat Workshop for Eastern, Central and Southern Africa and the Indian Ocean*, pp. 189–193. CIMMYT, Mexico.
- HINDS H. R. & FREEMAN C. C. 2005. *Persicaria*. In: FLORA OF NORTH AMERICA EDITORIAL COMMITTEE (eds), *Flora of North America North of Mexico*. **5**: 574–594. Oxford University Press, New York and Oxford.
- JØRGENSEN P. M. & LEÓN-YÁNEZ S. (eds) 1999. Catalogue of the vascular plants of Ecuador. *Monogr. Syst. Bot. Missouri Bot. Gard.* **75**: 1–1181.
- KEFYALEW G., SHAMBEL M., AMANUEL G., WORKIYE T. & MEKONNEN K. 2000. Survey of weed community structure in bread wheat in three districts of Arsi Zone in south-eastern Ethiopia. In: CIMMYT, *The Eleventh Regional Wheat Workshop for Eastern, Central and Southern Africa*, pp. 291–301. CIMMYT, Addis Ababa.
- KIM S.-T. & DONOGHUE M. J. 2008. Molecular phylogeny of *Persicaria* (Persicarieae, Polygonaceae). *Syst. Bot.* **33**(1): 77–86.

- KUBÁT K. & JEHLÍK V. 2003. *Persicaria pensylvanica* in der Tschechischen Republik. *Preslia* **75**: 183–188.
- LAMBON P. W., PYŠEK P., BOSNOU C., HEJDA M., ARIANOUTSOU M., ESSL F., JAROŠÍK V., PERGL J., WINTER M., ANASTASIU P., ANDRIOPOULOS P., BAZOS I., BRUNDU G., CELESTI-GRAPOW L., CHASSOT P. & VILR M. 2008. Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. *Preslia* **80**: 101–149.
- LI A., BAO B., GRABOVSKAYA-BORODINA A. E., HONH S., MCNEILL J., MOSKAYIN S. L., OHBA H. & PARK C.-W. 2003. *Polygonaceae*. In: Z. Y. WU, P. H. RAVEN & D. Y. HONG (eds), *Flora of China*. **5**: 277–350, Science Press, Beijing & Missouri Botanical Garden Press, St. Louis.
- LI X., LI R., CHU S., ZHANG Y., WANG Y. & XU R. 2012. Species and distribution of weeds in tobacco fields in Shiyan, Hubei Province. *Chinese Tobacco Science* **33**(4): 55–59.
- MEIER W. 2006. Contribución al conocimiento de *Persicaria nepalensis* (Meisn.) H. Gross y *P. capitata* (Buch.-Ham. ex D. Don) H. Gross, especies invasoras en el Parque Nacional el Ávila, Venezuela. *Acta Bot. Venez.* **29**(1): 1–16.
- MIREK Z., PIĘKOŚ-MIRKOWA H., ZAJĄC A., ZAJĄC M. (eds) 2002. Flowering plants and pteridophytes of Poland – a checklist. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- NIMJE P. M. 1988. Weed survey of potato fields of the higher hills of Nilgiris. *Indian Journal of Weed Science* **20**(4): 26–31.
- NJOROGE J. M. 1994. Weeds and weed control in coffee. *Exp. Agric.* **30**(4): 421–430.
- NOGUEIRA I., ORTIZ S. & PAIVA J. A. R. 2006. *Polygonaceae*. In: G. V. POPE, R. M. POLHILL & E. S. MARTINS (eds), *Flora Zambesiaca*. **9**(3): 1–49. Royal Botanic Gardens, Kew.
- PIGNATTI-WIKUS E. 1973. *Polygonum nepalense* Meisn. avventizia nel Bellunese. *Giorn. Bot. Ital.* **107**(6): 291–294.
- QAISER M. 2001. *Polygonaceae*. In: S. I. ALI & M. QAISER (eds), *Flora of Pakistan*. **205**: 1–205. University of Karachi, Karachi & Missouri Botanical Garden Press, St. Louis.
- RODER W., DOCHEN T., NIDUP K. & DORJI S. 2009. Weed management challenges in small-holder potato systems in Bhutan. *Weed Research* **49**(3): 300–307.
- STACE C. 2010. *New flora of the British Isles*. 3rd ed. Cambridge University Press, Cambridge.
- TAN K. & BAYTOP A. 1995. *Polygonum nepalense* Meisn. in Turkey. *Turkish J. Bot.* **19**(6): 601–602.
- TOKARSKA-GUZIK B., DAJDOK Z., ZAJĄC M., ZAJĄC A., URBIŚZ A., DANIELEWICZ W. & HOŁDYŃSKI C. 2012. Alien plants in Poland with particular reference to invasive species. Generalna Dyrekcja Ochrony Środowiska, Warszawa (in Polish with English summary).
- VERLOOVE F. 2013. *Persicaria nepalensis*. In: *Manual of the Alien Plants of Belgium*. [August 2013]. <http://alienplants-belgium.be/node/3689>.
- VIBRANS H. & HANAN-ALIFI A. M. 2008. *Polygonum nepalense* (*Polygonaceae*), una planta invasora nueva para México. *Acta Bot. Mex.* **82**: 1–6.
- WEBB D. A., CHATER A. O. & AKEROYD J. R. 1993. *Polygonum* L. In: T. G. TUTIN, N. A. BURGESS, A. O. CHATER, J. R. EDMONDSON, V. H. HEYWOOD & D. M. MOORE (eds), *Flora Europaea*. **1**: 91–97. Cambridge University Press, Cambridge.
- YASMIN G. 2009. Taxonomic studies of two major genera *Polygonum* L. (complex) and *Rumex* L. of *Polygonaceae* from Pakistan. PhD thesis. Department of Plant Sciences Quaid-i-Azam University, Islamabad.

Received 27 December 2013