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Population variation in *Persicaria salicifolia* (BROUSS. ex WILLD.) ASSENOV (Polygonaceae) in Nigeria

With one Figure and 4 Tables

Summary

Study of six living population samples and herbarium specimens of *Persicaria salicifolia* from Nigeria revealed considerable variability in vegetative and floral characters. Two subspecies, one of which is a new one (subsp. nova, p. 516), are recognised. Experimental cultivation showed that the combination of distinguishing characters for each subspecies remains intact under uniform conditions in the botanical nursery.

Introduction

Persicaria salicifolia (BROUSS. ex WILLD.) ASSENOV is one of the ten species of the genus represented in West Africa (AYODELE 2000). It is a white to pink flowered annual herb erect or semi-decumbent occupying marshy areas along river banks in alluvial soils. The species is widespread in Nigeria extending from the Southern to the Northern part of the country and the Cameroon mountains. It occurs at sea level to as high as c. 2400 m in the Mambilla Plateau and the Cameroon mountains. Heterostyly is known to occur in several groups of the Polygonaceae, e.g., *Fagopyrum* GAERTN. (HONG & CHOI 1998), *Koenigia* L. (HEDBERG 1997), *Oxygonum* BURCH. (GRAHAM 1957) and partly in *Persicaria* MILL. (STANDFORD 1925). In all these cases, distyly seems to be the most prevalent condition with long and short styled flowers. However, the phenome-

Zusammenfassung

Variabilität der Population von *Persicaria salicifolia* (BROUSS. ex WILLD.) ASSENOV (Polygonaceae) in Nigeria

Studien an sechs lebenden Populationsproben und Herbar-Proben von *Persicaria salicifolia* aus Nigeria erbrachten eine beachtliche Variabilität der vegetativen und floralen Eigenschaften. Zwei Unterarten, eine von ihnen neu (subsp. nova) wurden verzeichnet. Kulturversuche zeigten, dass die Kombination der kennzeichnenden Merkmale jeder Unterart unter gleichen Bedingungen in einer botanischen Anzucht unverändert bleiben.

non of heterostyly has not yet been reported in *Persicaria salicifolia*. Preliminary examination of available specimens in the herbaria and studies of six living populations in Nigeria revealed the two morphological groups constituting this taxon. These groups are described as a prelude to the full taxonomic revision of the family Polygonaceae in West Africa.

Materials and methods

Specimens have been examined in the following herbaria: FHI, UIH, LUH and IFE. Abbreviations follow HOLMGREN et al. (1981). Six populations were sampled in Nigeria using the mass collection technique of ANDERSON (1941, 1943). About 10–20 mature plants of each population were collected at random depending on the size of the populations. The following characters among others were assessed: leaf length and width, blade length, petiole length, ochrea length and indumentum. All mea-

surements were taken at comparable positions on all plants of each population. All plants were raised from stem cuttings in the Nursery of the University of Ibadan with a view to determining the plastic responses of each of the populations. Voucher specimens prepared for all specimens are deposited in the herbarium of the Department of Botany and Microbiology, University of Ibadan. The localities, collectors and numbers are given in Table 1.

Floral characters

The flowers of plants from six populations sampled in the field were collected and dissected with the aid of the dissecting needles and microscope. The relative lengths of the filaments and styles were measured with the micrometer eye-piece. About 10–20 samples were used for each population.

Pollen morphology

Pollen grains obtained from the plants were prepared for study using the acetolysis method (ERDTMAN 1960).

The pollen grains were observed and studied using the Kyowa Medilux 12 Microscope. Descriptive statistics of mean, standard deviation and standard error were calculated for all floral and pollen variables. Calculations were based on 20 pollen grains measurements.

Table 1
Sources of population samples of *Persicaria salicifolia*

Sample No.	Popul. No. Collect. No.	Locality	Collector
1	015	Itamerin, Ago Iwoye, Ogun State, Nigeria	AYODELE
2	016	Onabamiro Road, Ago Iwoye, Ogun State, Nigeria	AYODELE
3	017	Gaddo pond area, Ago Iwoye, Ogun State, Nigeria	AYODELE
4	020	Adegbayi, Ife Road, Ibadan, Oyo State, Nigeria	AYODELE
5	026	Kakara village, Mambilla Plateau, Taraba State, Nigeria	AYODELE
6	027	Kusuku village, Mambilla Plateau, Taraba State, Nigeria	AYODELE

Results

Two groups are recognised in the six populations. The first group comprises populations 015, 016, 017 and 020 from Southwestern Nigeria while the second group is made up of populations 026 and 027 from the Mambilla Plateau in Northeastern Nigeria. In the first group, the leaf size ranges from 12.23×1.11 cm² to 15.26×1.53 m² in populations 017 and 020 respectively. The petiole length ranges from 0.82 cm in population 015 to 1.09 cm in population 020. The longest ochrea of 2.01 cm was recorded in population 020 while the shortest ochrea of 1.80 cm was recorded in population 015. Cilia length ranges from 1.07 cm in population 020 to 1.33 cm in population 016 (Table 2).

In the second group, the leaf sizes are comparatively smaller, 8.31×0.71 cm² in population 026 and 8.45×0.71 cm² in population 027. The petioles are also relatively shorter with 0.50 cm and 0.53 cm in the two respective populations. Ochrea and cilia are usually shorter than in the first group, the longest being 1.65 cm and 0.97 cm respectively (Table 2). Populations making up the first group have flowers which are pink or white, short styles with a mean length of 0.1 mm and a mean stamen length of 0.22 mm (Table 3). The mean pollen diameter for this group is 40.33 µm (Table 3). The second group comprising population 026 and 027 has long styled plants with a mean style length of 0.14 mm and a mean stamen length of 0.12 mm, while the mean pollen diameter is 42.43 µm (Table 3). Pollen grains of both groups are spheroidal and poly-pantoporate. Tepals in both groups are usually five while stamens range from seven to nine but are usually eight. Most recorded cases of stamens were in the second group of populations 026 and 027 from the Mambilla Plateau. Carpels are usually three in number.

Experimental cultivation

The experimental cultivation revealed that the combination of distinguishing characters, both qualitative and quantitative for each population and each group remains intact under uniform conditions in the nursery (Table 4).

Table 2
Leaf morphological characters of *Persicaria salicifolia* populations

Popul. No.	Leaf length	Leaf width	Blade length	Petiole length	Ochrea length	Cilia length
015	11.80–15.30	0.80–1.40	11.10–14.70	0.70–1.00	1.50–2.00	0.90–1.60
	13.65 ± 0.39	1.17 ± 0.07	12.83 ± 0.38	0.82 ± 0.03	1.80 ± 0.05	1.28 ± 0.07
016	12.40–15.40	1.20–1.60	11.50–14.40	0.80–1.30	1.80–2.00	0.90–1.80
	14.43 ± 0.26	1.39 ± 0.04	13.43 ± 0.24	1.00 ± 0.04	1.95 ± 0.03	1.33 ± 0.12
017	10.50–13.50	1.00–1.20	9.70–12.50	0.80–1.10	1.80–2.00	0.80–1.30
	12.23 ± 0.26	1.11 ± 0.02	11.36 ± 0.25	0.87 ± 0.03	1.92 ± 0.03	1.08 ± 0.04
020	12.70–18.30	1.10–2.00	12.20–17.50	0.50–1.90	1.80–2.00	0.80–1.40
	15.26 ± 0.32	1.53 ± 0.05	14.53 ± 0.31	1.09 ± 0.44	2.01 ± 0.03	1.07 ± 0.03
026	6.20–11.00	0.50–0.90	5.70–10.50	0.30–0.60	0.60–2.00	0.60–1.40
	8.51 ± 0.30	0.71 ± 0.03	7.99 ± 0.32	0.50 ± 0.02	1.60 ± 0.07	0.97 ± 0.05
027	5.80–11.10	0.50–1.00	5.20–10.70	0.30–0.60	1.00–2.00	0.60–1.20
	8.45 ± 0.31	0.71 ± 0.03	7.92 ± 0.31	0.53 ± 0.02	1.65 ± 0.05	0.92 ± 0.04

All measurements in cm range/mean ± standard error

Table 3
Features of long and short styled flowers in *Persicaria salicifolia*

Popul. No. Location	Sample No.	Stamen length	Style length	Pollen type/ Shape	Equatorial diameter
Short styled					
015	10	0.21	0.09	spheroidal	35.0
		(0.22 ± 0.0)	(0.10 ± 0.0)		(41.91 ± 0.70)
		0.24	0.10		45.0
016	10	0.19	0.09	spheroidal	35.0
		(0.21 ± 0.0)	(0.10 ± 0.0)		(40.36 ± 0.81)
		0.21	0.12		45.0
017	10	0.21	0.09	spheroidal	35.0
		(0.22 ± 0.0)	(0.10 ± 0.0)		(38.64 ± 0.93)
		0.24	0.10		45.0
0.20	20	0.19	0.09	spheroidal	35.0
		(0.22 ± 0.0)	(0.10 ± 0.0)		(40.46 ± 1.2)
		0.25	0.10		50.0
Total	50 (\bar{x})	0.19	0.09		35.0
		(0.22 ± 0.0)	(0.10 ± 0.0)		(40.33 ± 0.52)
		0.25	0.12		50.0
long styled					
026	20	0.10	0.13	spheroidal	40.0
		(0.12 ± 0.0)	(0.14 ± 0.0)		(42.64 ± 0.73)
		0.14	0.15		45.0
027	20	0.10	0.13	spheroidal	35.0
		(0.12 ± 0.0)	(0.14 ± 0.0)		(41.82 ± 0.97)
		0.13	0.15		45.0
Total	40 (\bar{x})	0.10	0.13		35.0
		(0.12 ± 0.0)	(0.14 ± 0.0)		(42.23 ± 0.61)
		0.14	0.15		45.0

All mean measurements in mm: (mean ± s.e.)
min
max

Table 4
Comparison of cultivated and wild populations of *Persicaria salicifolia*

Popul. No.	Type	Leaf length	Leaf width	Blade length	Petiole length	Ochrea length	Cilia length
015	C	13.30 ^a	1.26 ^a	12.68 ^a	0.62 ^a	1.70 ^a	0.72 ^b
	W	13.65 ^a	1.17 ^a	12.83 ^a	0.82 ^b	18.0 ^a	1.28 ^a
016	C	13.58 ^a	1.12 ^b	13.04 ^a	0.54 ^b	1.62 ^b	0.96 ^a
	W	14.43 ^a	1.39 ^a	13.43 ^a	1.00 ^a	1.95 ^a	1.33 ^a
017	C	11.98 ^a	1.16 ^a	11.30 ^a	0.68 ^b	1.56 ^b	1.00 ^a
	W	12.23 ^a	1.11 ^a	11.36 ^a	0.87 ^a	1.92 ^a	1.08 ^a
020	C	14.28 ^a	1.42 ^a	13.72 ^a	0.52 ^b	1.98 ^a	1.06 ^a
	W	15.26 ^a	1.53 ^a	14.53 ^a	1.09 ^a	2.01 ^a	1.07 ^a
026	C	8.32 ^a	0.78 ^a	7.88 ^a	0.44 ^a	2.02 ^a	0.98 ^a
	W	8.51 ^a	0.71 ^a	7.99 ^a	0.50 ^a	1.60 ^b	0.98 ^a
027	C	8.72 ^a	0.58 ^b	8.22 ^a	0.50 ^a	2.04 ^a	1.04 ^a
	W	8.45 ^a	0.71 ^a	7.92 ^a	0.53 ^a	1.65 ^b	0.92 ^a

C = cultivated; W = wild

Means with the same letter are not significantly different ($p \leq 0.05$) Duncan's Multiple Range Test.

The long styled plants remained small in habit with the usually pink flowers while the short styled plants remained larger with the white flowers. The results thus show that populations 026 and 027 are significantly different from the other populations (Table 4).

Discussion

Persicaria is noted to be an advanced genus in the tribe Persicarieae mainly on the basis of trichome structure, pollen, cleistogamy, heterostyly, entogamy, nectaries, reduced inner staminal whorl, dimerous carpels and fuse tepals (HARALDSON 1978; RONSE-DECRAENE & AKEROYD 1988). However, the number of carpels in all populations of *Persicaria salicifolia* investigated is three. The results of this study show that *P. salicifolia* is distylous. Plants with different kinds of pollen are usually found in populations of dimorphic species and those bearing each pollen type are incompatible but cross-compatible. This means that in distylous plants, only pollen from long styled flowers can pollinate the stigma of the short styled flowers while only pollen from the short styled flowers can pollinate the stigma of the long styled flowers. In essence, the morphological arrangement favours cross-pollination and is strongly reinforced by a physiological incompatibility system preventing fertilization

after illegitimate pollination (ORNDUFF 1964). Nevertheless, it has been found that in some species, morphological heteromorphism is not always accompanied by incompatibility (RAY & CHISAKI 1957) and as BAKER (1959, 1961) has shown, heterostyly as well as some of other systems promoting outbreeding are reversible allowing inbreeding to occur. Hence morphological changes, according to DAVIS & HEYWOOD (1963) may take place in the flowers, self compatibility alleles may arise in an incompatibility system while heterostyly gives rise to homostyly.

It is imperative to note that both forms of *Persicaria salicifolia* studied were self compatible (AYODELE 2000) and have the same type of pollen except for the minor differences in size. Thus it is doubtful if functioning heterostyly occurs in this taxon, since the long styled plants have a much more restricted distribution in the Mambilla Plateau than the short styled ones. Moreover, most of the specimens (c. 84 %) in all herbaria visited are short styled. In accordance with the observation of HEDBERG (1997) on *Koenigia delicatula* (MEISSN.) HARA, the situation in *P. salicifolia* can as well be treated as a case of abolished or non-functional heterostyly where the original self compatibility system has broken down and the long styled type has become very rare.

The results of experimental cultivation show that the characters are genetically fixed



Fig. 1
Persicaria salicifolia (BROUSS. ex WILLD.) ASSENOV, subsp. *mambillensis* AYODELE subsp. nova. Type specimen

and not subject to phenotypic responses in different habitats. The cultivated samples of the two groups retained their characteristic appearances and the various distinguishing features for each of the two morphological forms remained intact. This shows that *P. salicifolia* consists of two entities which are recognised here at the subspecific level. The morphological evidence regarding these two subspecies seems unequivocal. The separate geographical and altitudinal range of the two subspecies appear to reflect ecological differences that are genetically based. In deciding upon the recog-

nition of these taxa, cognisance was taken of the subspecies definition which recognises geographical races of a species with well marked though sometimes small morphological characters (VALENTINE & LOVE 1958).

Populations 015, 016, 017 and 020 of *P. salicifolia* are referable to the subspecies *salicifolia* while populations 026 and 027 are recognised as the new subspecies *mambillensis* named after the locality where the plants were collected. The subspecies is described and a key is produced for recognising the two taxa.

Key to the subspecies of *Persicaria salicifolia*

- 1 Leaves 10.50–18.30 (14.16) × 0.80–2.00 (1.35) cm², petioles 0.50–1.30 (0.83) cm, styles short, 0.09–0.12 (0.10) mm, flowers white or tinged with pink at lower altitude. (a) subsp. *salicifolia*
 1* Leaves 5.80–11.0 (8.84) × 0.50–1.00 (0.70) cm², petiole 0.30–0.60 (0.51) cm, styles long, 0.13–0.15 (0.14) mm, flowers predominantly pink, at higher altitude (b) subsp. *mambillensis* (Fig. 1)

a subsp. *salicifolia*

Annual to perennial herb, erect to semi-decumbent, leaves linear lanceolate. Leaves 10.50–18.30 (14.16) cm long and 0.80–2.00 (1.35) cm wide, petiole strigose, 0.50–1.30 (0.83) cm, ochreae 1.20–3.50 (1.97) cm long, cilia 0.30–1.50 (0.87) cm long, fruit 0.20 × 0.15–0.30 × 0.20 cm, brown to black, pollen 35–50 (40.97) μm in diameter, styles 0.09–0.12 (0.10) mm, flowers white.

Distribution: Widespread extending from Nigeria to Cameroon and Liberia.

Ecology: In alluvial soil, river banks, swamps and ditches.

b subsp. *mambillensis* AYODELE subsp. nova

Annus ad herbam perennem, erectus vel decubitus, folia anguste linearis-lanceolata, 5.80–11.00 (8.48) cm longus, et 0.50–1.00 (0.70) cm latus, petiolus strigosus, 0.30–0.60 (0.51) cm, ochrea 0.60–2.00 (1.62) cm longus, cilia 0.60–1.40 (0.95) cm longus, fructus 0.15 × 0.10–0.31 × 0.20 cm, fulvus ad nigrum, granum pollene 35–45 (42.23) μm in diametrum, stylus 0.13–0.15 (0.14) mm. Flores roseus.

Annual to perennial herb, erect or decumbent, leaves narrowly linear lanceolate, 5.80–11.00 (8.48) cm long and 0.50–1.00 (0.70) mm wide, petiole strigose, 0.30–0.60 (0.51) cm,

ochreae 0.60–2.00 (1.62) cm long, cilia 0.60–1.40 (0.95) cm long, fruit 0.15 × 0.10 cm–0.31 × 0.20 cm, brown to black, pollen 35–45 (42.23) μm in diameter, styles 0.13–0.15 (0.14) mm, flowers pink (Fig. 1).

Distribution: Restricted to the Mambilla Plateau and the Cameroon mountains.

Ecology: Alluvial soils in streams, river banks and swamps.

Type: Nigeria, Taraba State, Sardauna division, Mambilla Plateau, Mayo sewa, Kusuku, UIH 22230 AYODELE 027, 22.09.1997. (Holotype, UIH).

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References

- ANDERSON, E. 1941: The technique and use of mass collections in plant taxonomy. – *Ann. Miss. Bot. Gard.* **28**: 287–292.
 ANDERSON, E. 1943: Mass collections. – *Chron. Bot.* **7**: 378–380.
 AYODELE, A. E. 2000: Systematic studies in the family Polygonaceae. – Univ. Lagos, Unpubl. Ph. D. Thesis. 214 pp.
 BAKER, H. G. 1959: Reproductive methods as factors in speciation in flowering plants. – *Cold Spring Harb. Symp.* – *Quant. Biol.* **24**: 177–191.

- BAKER, H. G. 1961: Rapid speciation in relation to changes in the breeding systems of plants: 881–885. – Recent advances in botany. – Toronto.
- DAVIS, P. H. & HEYWOOD, V. H. 1963: Principles of Angiosperm taxonomy. – Edinburgh and London.
- ERDTMAN, G. 1960: The acetolysis method – a revised description. – Svensk Bot. Tidskr. **54**: 561–564.
- GRAHAM, R. A. 1957: A revision of *Oxygonum* (Polygonaceae – Polygoneae). – Kew Bull. **11**: 145–172.
- HARALDSON, K. 1978: Anatomy and taxonomy in Polygonaceae subfam. Polygonoideae MEISSN. emend. JARETZKY. – Symbol. Bot. Upsal. **22** (2): 1–95.
- HEDBERG, O. 1997: The genus *Koenigia* L. emend. HEDBERG (Polygonaceae). – Bot. J. Linn. Soc. **124**: 295–330.
- HOLMGREN, P. K.; KEUKEN, W. & SCHOFIELD, E. K. 1981: Index Herbariorum Part 1. The Herbaria of the World, ed. 7. – Regnum Veg. **106**.
- HONG, S. P. & CHOI, J. H. 1998: Pollen morphology of the genus *Fagopyrum* MILL. (Persicariaceae – Polygoneae). – Korean J. Plant Taxon. **28** (3): 281–300.
- ORNDUFF, R. 1964: The breeding system of *Oxalis suksdorfii*. – Amer. J. Bot. **51**: 307–314.
- RAY, P. M. & CHISAKI, H. F. 1957: Studies on *Am-sinkia* L. A synopsis of the genus with a study of heterostyly in it. – Amer. J. Bot. **44**: 529–536.
- RONSE-DECRAENE, L. P. & AKEROYD, J. R. 1988: Generic limits in *Polygonum* and related genera (Polygonaceae) on the basis of flora characters. – Bot. J. Linn. Soc. **98**: 321–371.
- STANDFORD, E. E. 1925: The inflorescence and flower-form in *Polygonum* subgenus *Persicaria*. – Rhodora **27**: 41–47.
- VALENTINE, D. H. & LOVE, A. 1958: Taxonomic and biosystematic categories. – Brittonia **10**: 153–166.

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