

POA RAMIFER (POACEAE: POOIDEAE: POEAE: POINAE),
A NEW AERIALLY BRANCHING GYNOMONOECIOUS SPECIES FROM PERU

Robert J. Soreng and Paul M. Peterson

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
sorengr@si.edu; peterson@si.edu

ABSTRACT

A new species, **Poa ramifer** Soreng & P.M. Peterson, from Ancash, Peru is described and illustrated. It differs from all other American species of *Poa* in having erect, aerially branching culms with lateral shoots that persist and flower in subsequent seasons. The spikelets of the gynomonoecious plants have proximal perfect and distal pistillate florets with dimorphic lodicules.

RESUMEN

Se describe e ilustra una nueva especie, **Poa ramifer** Soreng & P.M. Peterson, del departamento de Ancash, Perú. Se diferencia de las restantes especies americanas de *Poa* por tener cañas erguidas, ramificadas, ramificaciones laterales persistentes que florecen en estaciones subsecuentes. Las plantas ginomonoicas tienen espiguillas con antecios proximales hermafroditas y antecios distales pistilados, con lodículas dimorfas.

On a high ridge above a tributary north of the canyon of the Rio Santa along the western slopes of the Andes in the Provincia de Corongo, Departamento Ancash of northern Peru, the authors in 2008 collected a *Poa* that was undoubtedly a new species. The type collection was gathered about eight km above Pilipampa, on a winding road between Bambas and Miraflores, below the pass between the provinces of Corongo and Pallasca. About 100 plants were noted in the one population we found on the south facing shrubby slopes between 2750 and 3040 m in elevation. No other stations are known for the species, but we expect the new species to be locally frequent on similar slopes in areas that have been minimally grazed by domestic animals or otherwise minimally disturbed. We have examined collections of *Poa* from South America, particularly from Peru at CPUN, MO, MOL, US, and USM [acronyms follow Thiers (2009)], but found no other collections matching the new species.

Poa ramifer Soreng & P.M. Peterson, sp. nov. (**Figs. 1 A–C, 2 A–O**). TYPE: PERU. DEPARTAMENTO ANCASH: Provincia Corongo, S side of pass between Bambas (Prov. Corongo) and Miraflores (Prov. Pallasca), 8 km above Pilipampa and 17 km by road NW of Bambas ($8^{\circ}34'15.5"S$, $78^{\circ}02'33.1"W$), slopes with *Baccharis*, *Salvia*, and yellow-flowered Asteraceae shrubs, 2788 m, 20 Mar 2008, P.M. Peterson & R.J. Soreng 21804 (HOLOTYPE: US!; ISOTYPES: B!, BAA!, COL!, CONC!, CORD!, CPUN!, K!, L!, LE!, LPB!, MA!, MO!, MOL!, NY!, PE!, QCA!, SI!, US!, US!, USM!).

A Pois Americae, supernis nodis veterum erectorum florentium culmorum ramosis et floriferis differt.

Plants perennial, cespitose from broad based clumps (to 1 m diam.) with extravaginal primary shoots from a knotty base; primary roots 0.4 mm diam.; primary culms 80–100 cm tall (including panicles), erect or slightly decumbent, 1–1.5 mm diam. at base, smooth, perenniating with 7–10-leaf bearing nodes, nodes smooth, glabrous, with intravaginal and extravaginal leafy secondary shoots arising from nodes 5–60 cm above base along the primary flowering culms, secondary shoots flowering in the next season and developing a few new leafy tertiary shoots. **Leaves** mostly cauline; sheaths slender, slightly compressed, scabridulous, papery (not becoming fibrous), lower sheaths closed up to the ligule, upper sheaths 2–4 times as long as their blades, closed ca. 40% of their length, lightly scabridulous; blades 2–15 cm long, 1–2 mm wide, flat or folded on drying, thin, shallowly keeled, abaxially and adaxially scabridulous mostly over the costae, with 6 or 7 narrow and well spaced costae (intercostal area 1–3 times as wide as each costal rib) on either



Fig. 1. *Poa ramifer* Soreng & P.M. Peterson [P.M. Peterson & R.J. Soreng 21804 (US)]. A. Habit. B. Lateral extravaginal shoot with cataphyll. C. Panicle.

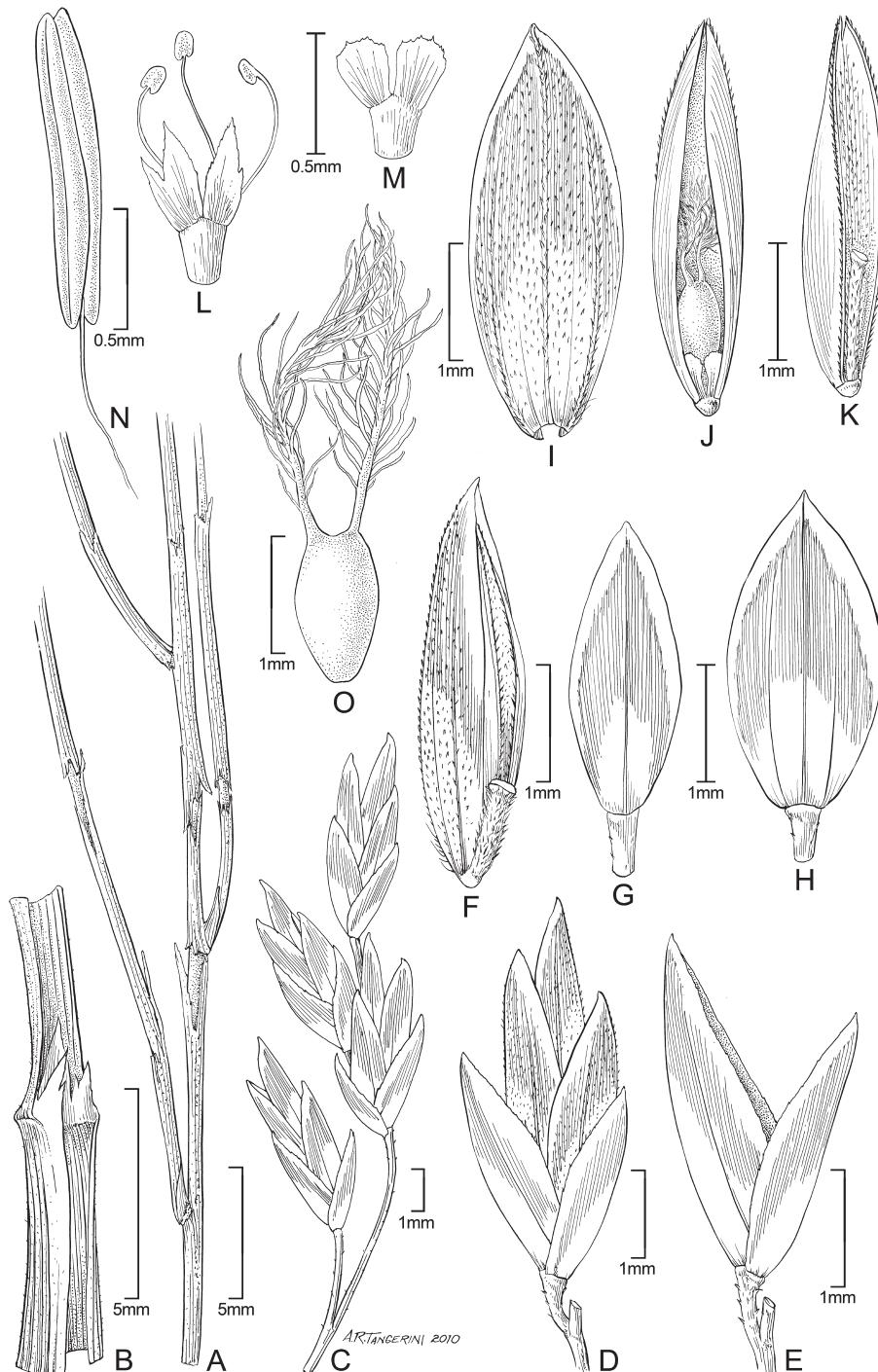


Fig. 2. *Poa ramifer* [P.M. Peterson & R.J. Soreng 21804 (US)]. A. Extravaginal branching from old culm. B. Ligule. C. Four spikelets. D. Spikelet. E. Lower and upper glumes in lateral view. F. Proximal floret (perfect). G. Lower glume dorsal view. H. Upper glume dorsal view. I. Lemma of proximal floret, dorsal view. J. Flower (anthers removed) inside palea of proximal floret. K. Palea lateral / ventral view of proximal floret. L. Flower of distal pistillate floret, lodicules and staminodes (pistil removed). M. Lodicules of proximal floret. N. Anther of proximal floret (1 of 3). O. Pistil of distal floret.

ARTANGERINI 2010

side of the midrib, adaxially with single rows of bulliform cells flanking the midrib; ligules 2–4 mm long, membranous, whitish, usually with a few deep lacerations, abaxially scabrous, those of the lower shoots connate in front, of the upper shoots grading to long decurrent, apex acute. **Panicles** 4–10 cm long, erect except for nodding tip, open, sparse with 20–65 spikelets, lowest internodes 1.8–2.6 cm long; branches 1 or 2(–3) per node, capillary, 0.1–0.2 mm in diam., flexuous, widely spreading to steeply reflexed, sparingly to moderately scabridulous along the angles, longest 2.5–5.5 cm long with 3–10 spikelets in the distal halves; pedicels shorter than the spikelets, scabridulous. **Spikelets** (2)3–4(–5)-flowered, laterally compressed, proximal (1–)2 or 3 florets perfect, distal 1 or 2 florets pistillate; glumes 2.2–3.2 mm long, unequal, keeled, smooth or lightly scabridulous, edges smooth to closely scabridulous, apex acute; lower glumes 2.2–2.4 mm long, lanceolate, 1-nerved; upper glumes 2.9–3.2 mm long, 0.9–1.35 mm wide, ca. twice as wide as lower, broadly lanceolate 3(or 4)-nerved; rachilla internode between first and second floret ca. 0.6 mm long, densely scabrous, distal internodes ca. 1.1 mm long, moderately to densely scabrous, terete; callus laterally compressed in the dorsal side, smooth, glabrous or infrequently with a few dorsal hairs, the hairs to 0.8 mm long; lemmas 3.3–3.8 mm long, 0.7–1.1 mm wide, laterally compressed, strongly keeled, membranous, 5-nerved, marginal veins moderately pronounced, intermediate veins obscure to moderately pronounced, margins involute and narrowly white scarious, keel and marginal veins densely scabridulous, keel glabrous or sericeous with 1–several hairs near the base, the hairs to 0.4 mm long, surface between veins lightly to moderately scabridulous, silica cells common, surface between the marginal vein and edge moderate to densely scabridulous, edge smooth or sparsely to moderately scabridulous, apex acute; paleas equaling lemma in length, keels densely scabridulous, between keels moderate to densely scabridulous, flanges smooth, about as wide as the gap between the keels; lodicules 2, obtuse, glabrous, in perfect florets lodicules 0.2–0.3 mm long, unlobed or briefly lobed, in pistillate florets lodicules 0.5–0.6 mm long, lanceolate with a distinct lateral lanceolate lobe; stamens 3; anthers 2.0–2.8 mm long, or vestigial, then ca. 0.2 mm long; ovary glabrous, styles 2, terminal, adjacent, stigmas ca. 1.5 mm long, lanceoloid, white, with moderately to densely plumose branches from the base, primary branches sparingly rebranched; caryopses 1.7–2 mm long, narrowly lanceolate, hard, greenish, tightly adherent to the palea, hilum ca. 0.2 mm long, narrowly elliptic.

Distribution and Habitat.—Shrubby upper slopes of the canyon of the Rio Santa around Cerro Santo Toribio, with *Eragrostis lurida* J. Presl, *E. pilgeri* Fedde, *E. weberbaueri* Pilg., *Festuca* sp., *Melica scabra* Kunth, *Salvia* sp., *Baccharis* sp., and other Asteraceae shrubs, 2750–3040 m.

Comments.—*Poa ramifer* might be closely related to the more widespread *P. aequatoriensis* Hack. that occurs in relatively low elevations (for *Poa*) in Colombia, Ecuador, and Peru. In Peru the latter species occurs on the Amazonian side of the Andes as far south as Ayacucho in more mesic western slopes from 2300–3500 m (Tovar 1993). *Poa aequatoriensis* is a more mesophilic species that occasionally stools, roots at the nodes, and occasionally branches along the lower culms, but it does not branch well up into the old erect culms as in *P. ramifer* (Figs. 1 & 2). In addition, *P. aequatoriensis* has panicles with ascending branches, smaller spikelets with narrower glumes (up to 0.5 mm wide), lemmas (up to 0.7 mm wide) that are distinctly pubescent along the keel, and calluses that are distinctly webbed (contrast with Figs. 1 & 2). Both species apparently exhibit the same type of gynomonoecism (type **Ib**, see discussion below), as is common in northern Andean species of *Poa*, but the fertile anthers in *P. aequatoriensis* are only about 1 mm long.

DISCUSSION

The unusual branching habit within *Poa ramifer* (Figs. 1A & B; 2A) could be the result of natural selection favoring longevity of culms in the lower elevation habitats in Peru where few species of *Poa* occur. Of the 2990 grass collections PMP with collaborators have made in Peru between the years 1997 and 2008, 421 collections are of *Poa* (not including *Aphanelytrum*, *Dissanthelium*, *Tovarochloa*; see Gillespie et al. 2008: Although these genera are resolved within *Poa* in DNA analyses, they have not yet been transferred). Of these only eight *Poa* collections (including *P. ramifer*) were made below 3000 m, and of these only three were found below 2900 m. Even though species of subfamily Chloridoideae often dominate the lower elevations

of the coastal slopes of the Andes, vegetation is extremely sparse below 2000 m, except in riparian habitats. These open, low elevation slopes are evidently extremely xeric and not well suited for *Poa*. Temperatures at the type locality of *Poa ramifer* probably never drop below freezing [location of the type is well within the low of 0–4°C minimum temperature zone, and near the 4–8°C minimum; Servicio Nacional de Meteorología e hidrología del Perú (2009) website map], and cloud banks regularly occur in this zone (we saw a cloud bank and photographed it during our trip) providing humidity, dew, and infrequent rains, at least during the wet season. This habitat may have favored the development of above ground culms that persist in this species, as it has for species restricted to loma habitats of low elevations near the Pacific coast (Ferreyra 1953, e.g., *Oxalis gigantea* Barnéoud).

There are now 34 species of *Poa* (including *P. ramifer*) accepted for Peru by Soreng et al. (2003, updated on-line version, see 2009b). We predict that the new species belongs to the large, world-wide *Poa* subg. *Poa* supersect. *Homalopoa* (Dumort.) Soreng & L.J. Gillespie based on its absence of rhizomes, relatively closed and compressed sheaths, distinct lemma nerves, and scabrous palea keels (preliminary nuclear rDNA sequence data supports this placement; Lynn Gillespie, pers. comm.). Based on morphological characteristics, all native Peruvian species of *Poa* belong to supersect. *Homalopoa*. DNA sequences of 2/3 of the indigenous Peruvian *Poa* species (not including the new species) have been phylogenetically examined (Refulio-Rodríguez 2007; Gillespie et al. 2008; L. Giussani, L. Gillespie, M.A. Negritto, N.F. Refulio-Rodríguez, R.J. Soreng unpubl. data), and none have aligned outside of the group that we interpret as *P. supersect. Homalopoa*. The new species is most obviously distinct from all other species of *Poa* of the Americas in its peculiar branching habit. Individual plants of *P. ramifer* form large broad-based clumps (to 1 m diam at base), with 7–10-noded erect culms reaching one meter in height that are partly supported by shrubs (Fig. 3). A panicle terminates the main culm or terminates lateral shoots that originate well up along the previous season's culm (unusual within the genus). A similar aerial branching habit is known from a few Australian species of *Poa* supersect. *Homalopoa* sect. *Brizoides* Pilg. s.l. (e.g., *P. homomalla* Nees), and a few others in *P.* sect. *Brizoides* subsection *Australopoa* Soreng, L.J. Gillespie & S.W.L. Jacobs (e.g., *P. tenera* Hook. f., *P. jugicola* D.I. Morris, and *P. orthoclada* N.G. Walsh; Gillespie et al. 2009, Soreng et al. 2009a), but this habit has presumably been derived independently in Peru. Unlike two other South American species of *Poa* (*P. hieronymi* Hack. and *P. myriantha* Hack.) with long straggling multi-noded culms to 2 m, *P. ramifer* has anthers that are 2 mm long in the perfect florets (versus stamens 1 mm long in the perfect florets), calluses that are glabrous (infrequently with 1 or 2 short hairs present; versus web well developed), panicles that are 5–10 cm long with 20–65 spikelets (versus 20–36 cm long panicles with more than 100 spikelets), and erect culms that perenniate with new flowering culms arising from the upper nodes.

The assessment of the breeding system of the new species is a bit preliminary. Although the species was more common upslope, we only collected specimens from a few plants of *P. ramifer* as these were not common where we stopped. The plants collected were gynomonoecious, within the spikelets with the proximal 2 or 3 florets perfect and the distal 1 or 2 florets pistillate. Apparently the distal pistillate flowers produce seed, but only partially developed caryopses were found in the “perfect” flowers. This arrangement of sexes appears to fit one of four types of gynomonoecism detailed by Connor (1979; type **1b** as outlined by Soreng & Keil 2003) where spikelets consistently contain proximal perfect florets and distal pistillate florets. This type of gynomonoecism is present in at least 20 South American species of *Poa* (Anton & Connor 1995; Negritto & Anton 2000), although a few South American species of the genus exhibit a separate type called sequentially adjusted (as opposed to fixed types recognized by Connor 1979) gynomonoecism (Soreng & Keil 2003; e.g. *P. fibrifera* Pilg., *P. plicata* Hack., *P. horridula* Pilg.), wherein the frequency of pistillate flowers and spikelets increases through the season in some proportion of individuals within a population (best documented in North American species such as *P. cuspidata* Nutt. and *P. tracyi* Vasey). Further study of individuals of *P. ramifer* is needed to confirm whether the species is fixed or sequentially gynomonoecious (Soreng & Keil 2003), as there is extensive variation in breeding systems in *Poa* (Anton & Connor 1995), even within gynomonoecious species (Connor 1979; Negritto & Anton 2000; Soreng & Keil 2003).



Fig. 3. Habit of *Poa ramifer* [P.M. Peterson & R.J. Soreng 21804 (US)] in situ. Photo by R.J. Soreng.

This is the first time in *Poa*, so far as we are aware, that different lodicule forms within a spikelet have been noted between florets. In *P. ramifer* the lodicules are present but reduced in the proximal perfect florets in each spikelet, while these structures are fully developed in the distal floret(s) within the same spikelet. In the perfect florets the lodicules are short, blunt and unlobed (Fig. 2J & M), whereas lodicules of the pistillate florets are lanceolate and lobed (Fig. 2L) as is typical of most species of *Poa*. We know of no previous documentation of morphological dimorphism of the lodicules between pistillate and perfect florets within the same species of *Poa*. In the Chilean dioecious species, *P. cumingii* (sect. *Dioicopoa* E. Desv.) Trin., lodicules are absent or poorly developed in staminate florets and well developed in pistillate florets (RJS, pers. obs.). Lodicules in monoecious and dioecious species in some grass genera (e.g., *Pharus* and *Leptaspis*, and *Bouteloua*, respectively) are well developed in staminate florets but absent in pistillate florets (Judziewicz 1987; Kinney et al. 2008). In some gynodioecious species of *Cortaderia*, lodicules are longer in pistillate plants than in hermaphroditic plants (Connor 1973). These patterns seem to be diverse. Lodicules are thought to be involved in opening the grass floret at flowering. Why lodicules should be morphologically dimorphic between proximal perfect and distal pistillate florets within the same spikelet in this new species of *Poa*, and whether the pattern in *P. ramifer* occurs in related species, requires further study.

The habit of the new species is quite the opposite of the newly described *Poa unispiculata* Davidse, Soreng & P.M. Peterson (2010). The latter species grows in the Altiplano of Departamento Pasco, Peru, at ca. 4400 m. *Poa unispiculata* forms dense mats to 19 cm in diameter, is only 2 cm tall, and has inflorescences with a single spikelet and upwards of 200 inflorescences per individual. *Poa unispiculata* is gynodioecious with some plants that are pistillate and other plants that have perfect spikelets. As different as these two species may appear (see Davidse et al. 2010, Fig. 3), they have some similarities in growth form. The dwarf species (*P. unispiculata*) has many culm leaves/nodes (averaging 20–30) along the flowering culm with extremely short internodes (ca. 1 mm long). In this species the initial culms are prostrate or ascending, emerging within or at the edges of the mat, while the old culms from previous seasons produce adventitious roots at some of the older nodes. Just above some of the older nodes a succession of additional intravaginal leafy shoots are produced and many of these form new inflorescences, and so on, as the mat expands over time. Do the similarities in branching habit indicate a close phylogenetic relationship between these two Peruvian species? We hope to test this hypothesis by adding *P. ramifer* and *P. unispiculata* to our growing library of DNA sequence for the genus.

ACKNOWLEDGMENTS

We thank the National Geographic Society Committee for Research and Exploration (grant number 8087-06) for field and laboratory support; the Smithsonian Institution's, Restricted Endowments Fund, the Scholarly Studies Program, Research Opportunities, Atherton Seidell Foundation, and Biodiversity Surveys and Inventories Program, all for financial support; Alice R. Tangerini for illustrating the new species and pointing out the dimorphic lodicules; Christian Feuillet for help preparing the Latin diagnosis; Lynn Gillespie for preliminary DNA ITS and ETS sequence analyses; Zulma Rúgolo de Agrasar and Joseph Wipff for reviewing the manuscript; and the following colleagues who facilitated or assisted with fieldwork: Asuncion Cano Echevarría, María I. LaTorre, Nancy Refulio-Rodríguez, Jenny Rojas Fox, Isidoro Sánchez Vega, and Dorita Susaníbar Cruz.

REFERENCES

- ANTON, A.M. AND H.E. CONNOR. 1995. Floral biology and reproduction in *Poa* (Poaceae: Gramineae). *Austral. J. Bot.* 43:577–599.
- CONNOR, H.E. 1973. Breeding systems in *Cortaderia* (Gramineae) *Evolution* 27:663–678.
- CONNOR, H.E. 1979. Breeding systems in the grasses: a survey. *New Zealand J. Bot.* 17: 547–574.
- DAVIDSE, G., R.J. SORENG, AND P.M. PETERSON. 2010. *Poa unispiculata*, a new gynodioecious species of cushion grass from Peru with a single spikelet per inflorescence (Poaceae, Pooideae, Poae, Poinae). *J. Bot. Res. Inst. Texas.* 4:37–44.

- FERREYRA, R. 1953. Comunidades de vegetales de algunas lomas costaneras del Perú. Estac. Exp. Agrícola "La Molina," Bol. 53:1–88.
- GILLESPIE, L.J., R.J. SOREN, R.D. BULL, S.W.L. JACOBS, AND N.F. REFULIO-RODRÍGUEZ. 2008. Phylogenetic relationships in subtribe Poinae (Poaceae, Poeae) based on nuclear ITS and plastid *trnT-trnL-trnF* sequences. *Botany* 86:938–967.
- GILLESPIE, L.J., R.J. SOREN, AND S.W.L. JACOBS. 2009. Phylogenetic relationships of Australian *Poa* (Poaceae: Poinae), including molecular evidence for two new genera, *Saxipoa* and *Sylvipoa*. *Austral. Syst. Bot.* 22:413–436.
- JUDZIEWICZ, E.J. 1987. Taxonomy and morphology of the tribe Phareae. PhD Dissertation, University of Wisconsin, Madison.
- KINNEY, M.S., J.T. COLUMBUS, AND E.A. FARIAR. 2008. Unisexual flower, spikelet, and inflorescence development in monoecious/dioecious *Bouteloua dimorpha* (Poaceae, Chloridoideae). *Amer. J. Bot.* 95:123–132. 2008
- NEGRITTO, M.A. AND A.M. ANTON. 2000. Revision de las especies de *Poa* (Poaceae) del norte argentino. *Kurtziana* 28:95–136.
- REFULIO-RODRÍGUEZ, N.F. 2007. Systematics of *Disanthelium* Trin. PhD Dissertation, Claremont Graduate University, Claremont, California.
- SERVICIO NACIONAL DE METEOROLOGÍA E HIDROLOGÍA DEL PERÚ (SENAMHI). 2009. <http://www.senamhi.gob.pe/> (web-site maps accessed Dec. 2009).
- SORENG, R.J., L.J. GILLESPIE, AND S.W.L. JACOBS. 2009a. *Saxipoa* and *Sylvipoa* – two new genera and a new classification for Australian *Poa* (Poaceae: Poinae). *Austral. Syst. Bot.* 22:401–412.
- SORENG, R.J., L.M. GIUSSANI, AND M. NEGRITTO. 2003 [updated on line]. *Poa* L. In: R.J. Soreng, P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone, eds. Catalogue of New World grasses (Poaceae): IV. subfamily Pooideae. *Contr. U.S. Natl. Herb.* 48:505–580.
- SORENG, R.J. AND D. KEIL. 2003. Sequentially adjusted sex-ratios in gynomonoecism, and *Poa diaboli* (Poaceae), a new species from California. *Madroño* 50:300–306.
- SORENG, R.J., G. DAVIDSE, P.M. PETERSON, F.O. ZULOAGA, E.J. JUDZIEWICZ, T.S. FILGUEIRAS, AND O. MORRONE. 2009b. Catalogue of New World grasses. <http://www.tropicos.org/Project/CNWG> [2 Oct 2009, continually updated]
- THIERS, B. 2009. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> [continually updated]
- TOVAR, O. 1993. Las Gramineas (Poaceae) del Peru. *Ruizia* 13:1–480.