

A REVISION OF *PEDICULARIS* SERIES *CURVIPES* (PRAIN) HURUS. (*OROBANCHACEAE*)

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Pedicularis L. series *Curvipes* (Prain) Hurus. (= *Pedicularis* [unranked] *Curvipes* Prain) in the *Orobanchaceae* (often included in the *Scrophulariaceae* s.l.) is revised. It is demonstrated that the correct name for the series is *Pedicularis* ser. *Curvipes*, not *Pedicularis* ser. *Curvipedes* as used by at least two previous authors. Arguments are presented for the retention of the three existing species, *Pedicularis curvipes* Prain, *Pedicularis nagaensis* H.L.Li and *Pedicularis amplicollis* T.Yamaz., and the taxonomic history of each is summarized. *Pedicularis curvipes* from Sikkim and *Pedicularis nagaensis* from NE India are very similar but can be distinguished on corolla and seed characters. Flowering material of *Pedicularis curvipes* collected from cultivated material of uncertain origin in 1900 is positively identified as that species for the first time. The known geographical range of *Pedicularis nagaensis*, which was previously believed to be endemic to a restricted area of Nagaland in NE India, is extended to include Manipur. *Pedicularis amplicollis* from Bhutan is distinct from both the other two and easily separable by its woolly, 4-lobed calyx. A key to the series and formal taxonomic accounts of each species are provided. The relationships of the series with related series, particularly *Pedicularis* ser. *Furfuraceae*, are discussed.

Keywords. Arunachal Pradesh, Bhutan, India, *Orobanchaceae*, *Pedicularis*, *Pedicularis* series *Curvipes*, *Pedicularis* series *Furfuraceae*, *Scrophulariaceae*, Sikkim, typification.

INTRODUCTION

This paper developed out of the need to thoroughly reassess the taxonomic status of the plants known as *Pedicularis curvipes* Hook.f. and *Pedicularis nagaensis* H.L.Li (*Orobanchaceae* following recent views based on molecular phylogenetics research, e.g. Olmstead *et al.*, 2001), belonging to *Pedicularis* series *Curvipes* (Prain) Hurus. (= *Pedicularis* [unranked] *Curvipes* of Prain, 1890). It represents the first ever critical study of all known material of the whole group (now comprising three species) by a single team, and the first study of any kind relating to the group since 1963. The species are all very poorly known; two are represented by a single wild gathering (one of these species is also known from fragments of cultivated material more than a century old) while the third is known from seven specimens. The 10 specimens are scattered in six different herbaria in three countries (India, Japan and the UK) and have never before all been examined at the same time; indeed, two of them represent

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new records (one of those being an extension of range) for one of the species. Published information about the three species of the series is rather scanty and very scattered in the literature. This paper presents the results of an examination of all the known specimens and also draws together all the pertinent information from the various literature sources.

The original species of the series, *Pedicularis curvipes* Hook.f., was first described by J.D. Hooker (1884) on the basis of a collection from Sikkim (Tumbok) made by C.B. Clarke on 9 October 1870. Two specimens from this gathering have been seen. The holotype at Kew (K) bears the number *Clarke* 12764A on its label although neither this number nor the date of collection was cited in Hooker's protologue, which merely gave the locality. At CAL there is a small packet, mounted on the same sheet as a different specimen, *Clarke* 41344B (discussed below); this packet has its own label also dated 9 October 1870 although it lacks any collection number. The contents of this packet comprise a detached leaf, a small portion of stem, and a detached capsule, all of which match the K holotype; thus, given the agreement in collection date, these can be regarded as isotype material of *Pedicularis curvipes*.

Some years later, Clarke (1890) recorded *Pedicularis curvipes* from Jakpho (now Japvo) in the Naga Hills, about 600 km ESE of Sikkim and on the opposite side of the great Brahmaputra River valley. Clarke gave an altitudinal range of 9000–9900 feet but did not cite any specimens. We have seen material of two gatherings, both collected at Jakpho in October 1885: *Clarke* 41334A (K) and 41334B (CAL) from 9000 ft, and *Clarke* 41347 (CAL) from 9900 ft, and we presume that these specimens are the basis of those records. All these specimens lacked flowers. The two conserved at CAL were re-determined as *Pedicularis nagaensis* H.L.Li by S.K. Mukerjee in 1969.

Prain (1890) also listed three collections by Clarke for the species, one being Hooker's type from Sikkim and the other two from the Naga Hills ('in montibus Barêl, Japvo, 9,000–9,900 p. s. m.'). One of the latter two (*Clarke* 41334B from the Naga Hills) was also illustrated by him (Prain, 1890: pl. 35 f. A) under the name *Pedicularis curvipes*. Seed of '*Pedicularis curvipes*' was also illustrated by him (Prain, 1890: pl. 36). The source of the record from 'Barêl' is not known to us since both *Clarke* 41334 (A and B) and *Clarke* 41347 are simply labelled 'Jakpho' and 'Naga Hills', with altitude and date.

Prain (1890) regarded *Pedicularis curvipes* (in his sense) as a very distinct species and included it as the sole species in a new, monospecific group, '22. Curvipes'. Contrary to what has been assumed by many authors, for example Hurusawa (1948), Yamazaki (1988), Yang *et al.* (1998), Mill (2001), the 83 groups recognized by Prain (1890) as the lowest level in his taxonomic hierarchy are unranked. However, all the above-mentioned authors, and others, have assigned series rank to them in the past, and have attributed publication of the names, at series rank, to Prain (1890) whenever they believed him to be the author of the name. Prain did use the term 'series' in his discussions occasionally in that work (e.g. pp. 22, and 38 where he also used 'subsection' in referring to his 'B. *Striatae*'). However, he only formally

used two ranks, those of Division (misplaced: Arts. 5, 33.7) and Section. Therefore, contrary to what one of us wrote in Mill (2001: 60–61), all previous attributions of ‘series’ to Prain (1890) are incorrect. Tracking down the earliest valid usage of ‘*Curvipes*’ at series rank has been difficult. Bonati (1910: 20) called the group ‘*Curvipedes*’, a spelling also used by Li (1948: 86). However, Bonati did not assign rank or refer back to Prain’s description, and, though Li did give ‘*Curvipedes*’ series rank, he likewise provided no description nor any reference back to either Bonati or Prain that might have validated his use of the name. The earliest definite use of the name, at the rank of series, is by Hurusawa (1948). Again there was no description, but, because Hurusawa definitely attributed the name to Prain, one can connect the name with Prain’s group ‘22. *Curvipes*’ of 1890. Although Hurusawa did not provide a clear indication of the basionym reference, this was not required in 1948. Therefore, we here regard Hurusawa as the first person to have validly published the name *Pedicularis* series *Curvipes*; we regard it as a new combination based upon Prain’s unranked group ‘*Curvipes*’.

Ten years after Prain’s monograph appeared, Hooker (1900) published an amended, amplified description of *Pedicularis curvipes*, with a colour plate (no. 7735), in *Curtis’s Botanical Magazine*. This was based on flowering material that had been cultivated at the garden of A.K. Bulley at Ness, Neston, Cheshire (England; now Ness Botanic Gardens of the University of Liverpool), from seed sent by Prain from the Royal Botanic Gardens in Calcutta. By that time, plants from both Sikkim and the Naga Hills much further east had been identified as *Pedicularis curvipes*. Unfortunately the wild source of this seed was not stated in the article and no supporting documentation has been found; a letter to Prain from Bulley attached to the Kew specimen mentioned correspondence from Prain to Bulley that could well have contained such information, but also that Bulley had requested the return of those letters. Hence, they were not preserved at Kew. Hooker’s 1900 description added details of the young state of the flowering stem of *Pedicularis curvipes*, and a very full description of the flowers. At Kew there is a single flower, preserved in a packet also containing a leaf and a small length of stem bearing one seed capsule, that originates from this cultivated material but there is unfortunately no extant specimen of the plant itself. Prain (1903: 22) became aware of Hooker’s description and illustration and published a short note that again gave the description of the corolla, although in abbreviated form.

No further work was done on this group until nearly 40 years later when Fischer (1938) identified a new specimen from the Naga Hills, *N.L. Bor* 6425 (K), as *Pedicularis curvipes*. This specimen had been collected in flower at Japvo in September 1935 (Li, 1948) at an altitude of 2970 m. Fischer, seemingly unaware of Hooker’s 1900 description and illustration, claimed that his description and illustration of this specimen were the first to be given of the flowers of *Pedicularis curvipes*.

A decade later, Li (1948) described a duplicate of *Bor* 6425 (DD) as the new species *Pedicularis nagaensis* H.L.Li, regarding the latter as distinct from *Pedicularis curvipes*, which he thereby by implication restricted to the type from Sikkim.

According to Li (1948) *Pedicularis nagaensis* differs from *Pedicularis curvipes* in having wider leaves with dentate lobes and a calyx with foliaceous and distinctly serrate teeth. However, there is no evidence from Li's paper that he actually examined either the Sikkim type of *Pedicularis curvipes* or the fruiting plants from the Naga Hills collected by Clarke, which had until that time been treated as *Pedicularis curvipes*. Likewise there is no evidence (either in his paper or on the specimen) that he examined the packet at Kew containing flowering material from the plant cultivated by Bulley. Nor did he seem to be aware of either of the descriptions of the flowers of *Pedicularis curvipes* given by Hooker (1900) and Prain (1903), which were based on Bulley's living collection and which would have afforded additional characters by which to distinguish his new species from *Pedicularis curvipes*. Finally, he was apparently also unaware of the paper by Fischer (1938) which effectively included the first description of the flowers of *Pedicularis nagaensis* from the Kew specimen of *Bor* 6425, although Fischer had called it *Pedicularis curvipes*. Li was, however, aware of Prain's monograph and illustration and considered (presumably from study of those) that *Clarke* 41334B and Prain's illustration based on that specimen were referable to his new species *Pedicularis nagaensis*. Li's illustration of the calyx and corolla of his new species (Li, 1948: pl. I no. 3) matches the illustration of the calyx of what Prain had called *Pedicularis curvipes* – which is not unexpected, since Prain's drawings were based on Clarke's specimen 41334B at CAL from Jakhpo (Japvo) in Nagaland.

Twenty-five years later, Yamazaki (1963) described a third species of series *Curvipes*, *Pedicularis amplicollis* T.Yamaz., from Bhutan. *Pedicularis amplicollis* was stated to be related to both *Pedicularis curvipes* and *Pedicularis nagaensis*. It was differentiated from *Pedicularis curvipes* by its acutely serrate leaves, densely woolly calyx with 4 teeth that are foliaceous and incised-serrate, and by the glabrous galea of the corolla. From *Pedicularis nagaensis* he distinguished *Pedicularis amplicollis* by its lanate stems, and densely woolly 4-dentate calyx. We are uncertain whether Yamazaki actually examined material of *Pedicularis nagaensis* or *Pedicularis curvipes* or simply diagnosed his new species by reference to previous descriptions of them; none of the specimens we have examined (which appear to be all those available) bear his *determinavit* or *approbavit* slips which would provide evidence that he had seen them. We have examined the type of *Pedicularis amplicollis* (*S. Nakao* 523, holotype KYO) and have compared it with all the other specimens. We have confirmed the differences that Yamazaki observed; consequently we agree that *Pedicularis amplicollis* is a very distinct species, at least if placed within series *Curvipes*. The characters mentioned above easily separate it from the other two species. However, the question of whether *Pedicularis amplicollis* belongs in the same series as them requires separate consideration.

The most critical problem in *Pedicularis* series *Curvipes* is how to satisfactorily separate *Pedicularis nagaensis* from *Pedicularis curvipes*. The description and diagnostic features given in the protologue by Li (1948) are rather inadequate for the purpose and, using them alone, *Pedicularis nagaensis* could be synonymized with

Pedicularis curvipes. However, during the course of the present research we have found additional characters that previously have been either ignored or unrecorded and these provide sufficient grounds for taxonomic separation of these two entities at species rank. A major problem until now has been the uncertainty of the provenance of Bulley's cultivated plant, which could have come from either the western, Sikkim population (*Pedicularis curvipes*) or the eastern, Naga Hills one that was subsequently separated as *Pedicularis nagaensis*. Flowers of the western population seem never to have been collected in the wild and until now Hooker's description of the flowers of *Pedicularis curvipes* could not safely be assigned to that species because of uncertainty over the origin of the plant. However, we have managed to find seeds in capsules belonging to the type of *Pedicularis curvipes*, authentic material (Clarke 41334A) of the eastern plants called *Pedicularis nagaensis*, and in the one preserved seed capsule belonging to Bulley's cultivated material. The seeds differ in the ornamentation of their testa; the reticulations are much thicker-walled in the Sikkim type of *Pedicularis curvipes* than they are in the eastern plants. The seed from Clarke 41334A matches Prain's 1890 drawing of the seed (Prain, 1890: pl. 36) but is different to the seed of the type of *Pedicularis curvipes*. The origin of the seed that Prain's artist drew is not stated but it is assumed to be from Clarke 41334B, the source of the drawing of *Pedicularis curvipes* that is plate 35A of the same work. If so, the two seeds that Prain and ourselves used were taken from duplicate sheets of the same collection from Nagaland. Prain's drawing therefore represents seed of *Pedicularis nagaensis*, not *Pedicularis curvipes*. The seed from Bulley's plant exactly matches that from the Sikkim type specimen of *Pedicularis curvipes* and does not match the one from the Nagaland specimen Clarke 41334A, whose duplicate 41334B was determined by Mukerjee as *Pedicularis nagaensis*. Therefore we can at last be sure that Bulley's cultivated plant did originate from somewhere in Sikkim, as suggested by the heading of the article in *Botanical Magazine*. Consequently the flower contained in the same packet and the illustration of the plant (Hooker, 1900: t. 7735) can also for the first time be safely assigned to *Pedicularis curvipes*. This allows a comparison to be drawn between the floral characters of *Pedicularis curvipes* and *Pedicularis nagaensis* and for both to be compared with *Pedicularis amplicollis*.

Hooker (1900) described the flowers of *Pedicularis curvipes* as having a puberulous calyx tube 'one-third of an inch long' [c.8 mm], divided to 1/3 on the anterior side, and a calyx limb divided into 2 auriform, obovate-oblong, crenate lobules (a third posterior tooth is also mentioned in the Latin text but not in the English, and is shown as a very minute intermediate tooth in the drawing of the calyx at bottom left of t. 7735). Hooker's calyx measurement appeared to apply only to the tube, with no measurement being given for the lobes. The corolla was described as having a straight tube equalling the calyx; a labellum '3/4 poll.' [c.9 mm] wide; and an arcuate-incurved, puberulent galea ending in a decurved beak with entire apex; and completely glabrous filaments. The single corolla preserved at Kew from Bulley's plant (the source of Hooker's description) agrees with this description except that one pair of filaments is in fact very sparsely hairy. The packet contains one filament

dissected out separately; this and the other of its pair (still in the corolla) are completely glabrous but both of the other pair (again, in the corolla) have a few scattered, short, bristle-like hairs in the central region. We assume that Hooker overlooked these. Nevertheless, the paucity of staminal hairs and their confinement to the anterior pair differentiates *Pedicularis curvipes* from both *Pedicularis nagaensis* and *Pedicularis amplicollis*, which have all four filaments hairy almost throughout.

Fischer (1938) described the calyx of the eastern plant (later named *Pedicularis nagaensis* by Li) as tubular-campanulate, 6.5 mm long (overall), with the teeth 2.5 mm, dimensions that correspond approximately to Li's later description. Both authors mention two calyx lobes, with no mention of a third smaller posterior tooth like the one observed by Hooker (1900) and no posterior tooth is shown in the illustration by Li (1948). The calyx lobes were described as lozenge-shaped and pectinately toothed by Fischer (1938) and as flabellate and distinctly toothed by Li (1948). We have noted that (as shown in Li's drawing) the teeth of the two calyx lobes of *Pedicularis nagaensis* spread out like the claws of a bird's foot and this, combined with the sharper teeth, gives the lobes a totally different appearance to the much blunter, crenate ones of *Pedicularis curvipes*. Fischer (1938) and Li (1948) also noted that the corolla tube of the Nagaland plants was distinctly longer than the calyx, whereas Hooker (1900) stated that in *Pedicularis curvipes* the corolla tube was the same length as the calyx. In this character, *Pedicularis amplicollis* is intermediate, the corolla tube only slightly exceeding the calyx (neither $1.5 \times$ the calyx as in *Pedicularis nagaensis* nor equalling it as in *Pedicularis curvipes*).

Hooker (1900) described the galea of *Pedicularis curvipes* as puberulous (which has been confirmed by examination of the flower preserved at Kew) but there was no mention of galea indumentum in the descriptions of *Pedicularis nagaensis* flowers given by Fischer (1938, as *Pedicularis curvipes*) and Li (1948). In *Pedicularis amplicollis* the hood part of the galea is glabrous, a fact not noted in the protologue (Yamazaki, 1963), although the galea beak was correctly described as glabrous. *Pedicularis nagaensis* also has a glabrous galea hood. Therefore, *Pedicularis curvipes* can be distinguished from both the other two by its puberulous hood. The labellum of *Pedicularis curvipes* was described by Hooker (1900) as glabrous, and 'rose-coloured, white towards the mouth'. *Pedicularis nagaensis* also has a glabrous-margined labellum but *Pedicularis amplicollis* differs from both the other two in having the margin of the labellum minutely hairy.

TAXONOMIC POSITION

Maximowicz (1888) included *Pedicularis curvipes* in a list of species of *Pedicularis* of uncertain taxonomic position, at the end of his third synopsis of the genus. He considered that, on account of the axillary flowers and rather long-pedicelled calyces, it might be allied to *Pedicularis* ser. *Resupinatae* Maxim. but, in the absence (at that time) of any flowering specimens, it was impossible to assign the species to a proper place in his system. Prain (1890), again in the absence of flowers,

assigned it to the monospecific group *Pedicularis* [unranked] *Curvipes* which he placed (doubtfully) in *Pedicularis* 'Division' *Aduncae* sect. *Rhyncholophae* Bunge [unranked] *Hyposiphonanthae* Prain. 'Hyposiphonanthae' contained seven groups numbered 18 to 24 in the following order: *Pedicularis* [unranked] *Oxycarpae* Prain, *Pedicularis* [unranked] *Furfuraceae* Prain, *Pedicularis* [unranked] *Oliganthae* Prain, *Pedicularis* [unranked] *Microphyllae* Prain, *Pedicularis* [unranked] *Curvipes* Prain, *Pedicularis* [unranked] *Carnosae* Prain and *Pedicularis* [unranked] *Racemosae* Prain (= *Pedicularis* ser. *Resupinatae* Maxim.). On the basis of its newly discovered floral morphology, however, Hooker (1900) considered Prain's classification to be wrong and regarded the correct place for *Pedicularis curvipes* to be as a monotypic group within *Pedicularis* Division *Longirostres* sect. *Siphonanthae* [unranked] *Brevitubae* Prain. In the classification of Prain (1890), which was the most up to date at the time and was presumably the one Hooker was following, *Pedicularis* [unranked] B. *Brevitubae* contained only two other subordinate groups, numbered 6 and 7 as follows: *Pedicularis* [unranked] *Robustae* Prain and *Pedicularis* [unranked] *Macranthae* Prain. Those two groups are, however, very different in their habit and general floral morphology to *Pedicularis* ser. *Curvipes*. Both have flowers in definite racemose inflorescences (not axillary and scattered along the stems) and *Pedicularis* [unranked] *Macranthae* is additionally distinguished by its very distinctive dish-shaped corolla lower lip that is rotated through about 90°, something that would probably not have been apparent to Hooker (or Prain) unless he had seen the plants in the field. Even without such knowledge, however, it now seems strange that Hooker related *Pedicularis curvipes* to these groups that are so very different in habit and morphology.

Hurusawa (1948) also regarded *Pedicularis* ser. *Curvipes* as a member of 'Div. *Longirostres*' (which he renamed *Pedicularis* subgen. *Rhynchophorum* Hurus.) but gave the series a different sectional placement, as one of five within *Pedicularis* sect. *Rhyncholopha* Bunge subsect. *Resupinatae* (Maxim.) Hurus. This once again positioned *Pedicularis* ser. *Curvipes* along with *Pedicularis* ser. *Microphyllae* (Prain) Bonati, *Pedicularis* ser. *Carnosae* (Prain) Bonati, *Pedicularis* ser. *Furfuraceae* (Prain) Bonati and *Pedicularis* ser. *Resupinatae* Maxim., as Prain (1890) had done. A very similar placement had been proposed earlier by Limpricht (1924) although his hierarchical system used letters and symbols rather than formal taxonomic ranks. Tsoong (1956a) placed *Pedicularis* ser. *Curvipes* in his *Pedicularis* grex *Cladomania* (H.L.Li) P.C.Tsoong. This was approximately equivalent to *Pedicularis* sections *Cladomania* H.L.Li and *Phyllomania* H.L.Li of Li's system (Li, 1949) although with the transfer of two series – *Pedicularis* ser. *Carnosae* and *Pedicularis* ser. *Resupinatae* – that were not included in either of those sections by Li. *Pedicularis* sect. *Phyllomania* H.L.Li (1949) comprised *Pedicularis* ser. *Microphyllae*, *Pedicularis* ser. *Furfuraceae* and *Pedicularis* ser. *Polyphyllatae* Bonati ex H.L.Li (an illegitimate name; the earlier name *Pedicularis* ser. *Polyphyllae* Maxim. must be used under the current rules since there is, as yet, no mechanism for conserving the names of infrageneric ranks). Li placed *Pedicularis* ser. *Carnosae* and *Pedicularis* ser.

Resupinatae (which he called '*Pedicularis* ser. *Racemosae* Prain') in a different section, *Pedicularis* sect. *Haplophyllum* H.L.Li, and did not treat *Pedicularis* ser. *Curvipes* at all since its species were absent from China. In addition *Pedicularis* sect. *Cladomania* contained only *Pedicularis* ser. *Palustres* Maxim. [*Pedicularis* ser. *Palustres* contained what was later designated the lectotype of the genus, *Pedicularis sylvatica* L. (Britton & Brown, 1913); therefore it must be called *Pedicularis* ser. *Pedicularis*, and *Pedicularis* sect. *Cladomania* becomes *Pedicularis* sect. *Pedicularis*.] Thus, the classification of Tsoong (1956a) was similar to those of Hurusawa (1948) and Li (1949) although the names used were different. The infrageneric nomenclature and taxonomy of this group of species are very complex and in need of unravelling although that is a problem beyond the scope of this paper. Yamazaki (1988) treated the group broadly and used the name *Pedicularis* sect. *Pedicularis* for the section containing *Pedicularis* ser. *Furfuraceae* and *Pedicularis* ser. *Carnosae* (the only two series of *Pedicularis* sect. *Pedicularis* occurring in Nepal). Pending further nomenclatural and taxonomic work, the name *Pedicularis* sect. *Pedicularis* is used here in place of both *Pedicularis* sect. *Cladomania* H.L.Li and *Pedicularis* sect. *Phyllomania* H.L.Li. We therefore regard *Pedicularis* ser. *Curvipes* as belonging to *Pedicularis* sect. *Pedicularis*. Within that section, it seems to be closest to *Pedicularis* ser. *Furfuraceae*. The general habit, leaf shape and arrangement, and inflorescence type are all very similar to members of *Pedicularis* ser. *Furfuraceae*. Indeed, small plants of *Pedicularis furfuracea* Wall. ex Benth. are particularly similar in these characters to *Pedicularis curvipes* and *Pedicularis nagaensis* and could easily be confused. However, the three species of *Pedicularis* ser. *Furfuraceae* have either four or five calyx lobes; in *Pedicularis furfuracea* the four lobes are much reduced to acute teeth but in the other two they are more or less foliaceous and incised-serrate as in *Pedicularis* ser. *Curvipes*. The calyx tube in all three species of *Pedicularis* ser. *Furfuraceae* broadens out distally from a narrow base (this is least pronounced in *Pedicularis microcalyx* but very obvious in *Pedicularis furfuracea*). Capsule shape is a useful character to separate the members of the two series: in *Pedicularis furfuracea* and *Pedicularis pantlingii* of *Pedicularis* ser. *Furfuraceae* the capsule is very obviously ovoid-lanceolate, tapering markedly from base to apex, and the apiculus at the tip of the capsule is not displaced obliquely as it is in both species of *Pedicularis* ser. *Curvipes* whose ripe capsules are known. In these (*Pedicularis curvipes* and *Pedicularis nagaensis*), the capsule is ellipsoid to obovoid, broadest at or above the middle and with the apiculus strongly displaced obliquely (to the posterior or abaxial side, but appearing as though anteriorly displaced in *Pedicularis curvipes* as discussed above). *Pedicularis microcalyx* of *Pedicularis* ser. *Furfuraceae* has capsules most similar in that series to those of *Pedicularis* ser. *Curvipes*, being smaller than the other two species and with a somewhat displaced apiculus, but even in that species the broadest point of the capsule is below the middle, not at or above it. The seeds also differ in their morphology (in *Pedicularis* ser. *Furfuraceae* they are blackish and striate but not reticulate, in *Pedicularis* ser. *Curvipes*, so far as is known, pinkish and reticulate).

Pedicularis amplicollis is closer to *Pedicularis* ser. *Furfuraceae* than to the other two species of *Pedicularis* ser. *Curvipes* in having four calyx lobes instead of two. In *Pedicularis* ser. *Furfuraceae* the calyx is either split nearly to the base on the anterior side (*Pedicularis furfuracea* and *Pedicularis microcalyx* Hook.f.) or not at all (*Pedicularis pantlingii* Prain) whereas in *Pedicularis* ser. *Curvipes* the split is to 1/3–1/2 and thus falls somewhat intermediate between the extremes found in *Pedicularis* ser. *Furfuraceae*. However, *Pedicularis amplicollis* agrees with the other two members of *Pedicularis* ser. *Curvipes* in having the calyx broadest above the middle, not at or below it as in *Pedicularis* ser. *Furfuraceae*. Its immature capsule was described as ‘oblique oblonga acuminata’ which again more suggests placement in *Pedicularis* ser. *Curvipes* than a transfer to *Pedicularis* ser. *Furfuraceae*. Therefore, despite the presence of four calyx teeth instead of two, we consider that *Pedicularis amplicollis* is correctly placed at present and that no transfer is necessary. *Pedicularis* ser. *Curvipes* therefore contains three species. The original description of the series, however, requires emendation to accommodate *Pedicularis amplicollis*.

TAXONOMY

Pedicularis* series *Curvipes (Prain) Hurus., J. Jap. Bot. 22: 180 (1948). – *Pedicularis* [unranked] *Curvipes* Prain, Ann. Roy. Bot. Gard. (Calcutta) 3: 76 (1890); Limpricht, Repert. Spec. Nov. Regni Veg. 20: 240 (1924); Mill, Fl. Bhutan 2(3): 1214 (2001 as series). – *Pedicularis* [unranked] *Curvipedes* Bonati, Mém. Bot. Soc. France 18: 20 (1910), nom. nud. & orth. err.; Li, Taiwania 1: 86 (1948), nom. nud. & orth. err. – Type species: *Pedicularis curvipes* Hook.f.

Decumbent or prostrate herbs. *Leaves* all opposite, all alternate, or the lower ones (in the vegetative portion) opposite and the upper ones (in the flower-bearing portion) alternate; lamina pinnatisect with 2–5 pairs of segments. *Flowers* axillary and solitary, or (at least in *Pedicularis curvipes* early in the flowering season; *vide* Hooker, 1900) in a lax racemose inflorescence; lowest flowers opening first. *Calyx tube* with an anterior split, the slit sometimes appearing posterior due to twisting of the pedicel; *calyx teeth* 2 or 4, the posterior tooth absent or very reduced. *Corolla* pink or purple; tube equalling or longer than calyx, straight, glabrous; galea arcuate, with declinate or horizontal beak. *Filaments* hairy at least partially (nearly glabrous in *Pedicularis curvipes*). *Capsule* oblong-ovoid, proximally covered by the calyx, with oblique, pointed apex. *Seeds* (when known) pinkish-brown, narrowly cylindrical, with reticulate testa and an elaiosome at one end.

Three species in the eastern Himalayas from Sikkim to Manipur (Fig. 1).

Key to species

- 1a. Calyx woolly, with 4 apical foliaceous lobes; margin of labellum minutely pilose or ciliate; stem woolly-pubescent all round _____ **3. *P. amplicollis***



FIG. 1. Map showing distribution of *Pedicularis* species included in series *Curvipes*.

- 1b. Calyx glabrous or minutely glandular but not woolly, with only 2 apical foliaceous lobes (in *Pedicularis curvipes* also with a tiny posterior tooth in between); margin of labellum glabrous; stem glabrous, or only bifariously hairy _____ 2
- 2a. Corolla tube equalling calyx; beak of galea decurved; lobules of calyx lobes indistinct, obtuse and the calyx lobes not resembling a bird's claw; filaments nearly glabrous throughout (only a few scattered hairs) _____ **1. *P. curvipes***
- 2b. Corolla tube longer than calyx; beak of galea horizontal; lobules of calyx lobes distinct, acute, spreading outwards so that each calyx lobe resembles a bird's claw; filaments sparsely villous _____ **2. *P. nagaensis***

1. *Pedicularis curvipes* Hook.f., Fl. Brit. India 4: 316 (1884); Maxim., Mél. Biol. 12: 919 (1888); Prain, Ann. Roy. Bot. Gard. (Calcutta) 3: 76 & 151 (1890) p.p. (excl. pl. Nagaland, etiam t. 35, 36); Prain, J. Asiat. Soc. Bengal 72 (2, no. 20): 22 (1903);

Hook.f., Bot. Mag. 126: t. 7735 (1900; excl. cit. Clarke 1890: 51 et Prain t. 35 f. A); Limpricht, Repert. Spec. Nov. Regni Veg. 20: 240 (1924) p.p. excl. pl. Assam.; Tsoong, Acta Phytotax. Sin. 5: 60 (1956) p.p. (excl. pl. Nagaland); Yamazaki, Acta Phytotax. Geobot. 19(4): 111 (1963) in obs.; Mill, Fl. Bhutan 2(3): 1214 (2001). – Type: Sikkim, Tumbok, alt. 10,000 ft, 9 x 1870, C.B. Clarke 12764A (holo K!; iso, without collector's number, CAL!).

Perennial? *Stem* 30 cm or more, suberect at first then decumbent, unbranched or branched from base and also sometimes with a few irregularly spaced lateral branches, shortly bifariously puberulous. *Leaves* all cauline, opposite and petiolate; petiole c.8 mm, puberulous or nearly glabrous; lamina ovate in outline, 10–35 × 8–25 mm, pinnatisect (lowest leaves sometimes pinnatifid) with 3–5 pairs of lateral segments; segments 3–10 mm long, incised-dentate, -crenate or -lobate at least above; upper surface glabrous, lower surface sparsely white-furfuraceous. *Inflorescence* a lax terminal raceme of 7–11 flowers, pyramidal at anthesis, and also with remote axillary flowers; flowers in axils of leaf-like bracts that are caducous in fruit. *Pedicels* c.2 mm long in flower, 6–10 mm long in fruit, at first erecto-patent but very soon becoming decurved in fruit, somewhat twisted longitudinally at least in fruit (changing the orientation of calyx and capsule with respect to the axis). *Calyx* ovoid, 6–8 mm long, tube split to c.1/3 on anterior side, membranous, with 2 small obovate-oblong, crenate apical lobes (posterior), glabrous except for cilia along margins of anterior fissure and sinus between the 2 lobes. *Corolla* pale rose with whitish throat and darker pink galea, c.20 mm long; tube whitish, c.7 mm long, not exceeding calyx, glabrous, straight; galea puberulous and glandular, with vertical part c.5 mm long and bent slightly backwards with respect to tube, anther-bearing part arched and inflated, c.3 × 1.5 mm, attenuate into a slender, ± decurved beak c.5 mm long with emarginate apex; lower lip c.7 × 12 mm, 3-lobed; lateral lobes c.7.5 × 5 mm, obliquely rounded and very shallowly emarginate or undulate, middle lobe c.3.5 × 3.5 mm, emarginate. *Stamens* inserted near middle of corolla tube; 2 anterior glabrous, 2 posterior sparsely pilose in middle; anthers c.1.5 × 0.8 mm, thecae shortly acuminate at base. *Style* scarcely exerted. *Capsule* 8–10 × 3–4 mm, oblong-ovoid, asymmetric with the adaxial side convex but the abaxial much less so and with obliquely acuminate apex (apiculus short, appearing as though on adaxial side). *Seeds* pinkish-purple, narrowly cylindrical with basal elaiosome, 2.8–3.5 × 0.7–1 mm, testa reticulate; reticula thick-walled (walls raised above level of testa and paler than the rest of the testa), elliptic to circular in outline.

Distribution and ecology. Endemic to Sikkim where it seems to have been collected (or at least herbarium material preserved) only once as, except for the type, no other collections are known from the wild. (The cultivated material cited below was grown from seed of unknown origin.) Habitat not known; c.3050 m.

Flowering and fruiting. Flowering period in wild not known; flowered May in cultivation. Fruiting in early October (probably beginning at least in September).

Specimens examined. SIKKIM. Tumbok, 10,000 ft, 9 x 1870, C.B. Clarke 12764A (K, holotype); *ibid.*, 9 x 1870, C.B. Clarke s.n. (CAL, fragmentary isotype in packet, mounted on sheet also bearing Clarke 41334B from Nagaland). ENGLAND (CULTIVATED). Garden of A.K. Bulley, Ness, Neston, Cheshire, 1900, Bulley s.n. (fragments in packet, K!; iconotype of illustration in Bot. Mag. t. 7735, 1900).

The holotype at Kew bears the manuscript name '*Pedicularis sparsiflora* C.B. Clarke' on the original field label; this epithet was crossed out by Hooker, who wrote in pencil on the sheet above, '*Pedicularis curvipes* Hook.f.'. The epithet *sparsiflora*, which appears to have been a manuscript name of Clarke's, has since been used for a different species, *Pedicularis sparsiflora* Bonati (*Pedicularis* ser. *Oxycarpae*) from western China, whose type is Wilson 4257a (Bonati, 1908: 252).

Differs from *Pedicularis nagaensis* in the orientation of calyx lobes and capsule apiculus relative to the inflorescence axis. In *Pedicularis curvipes* the two calyx lobes are posterior but in *Pedicularis nagaensis* they are anterior. In *Pedicularis curvipes* the capsule apiculus is apparently adaxial but in *Pedicularis nagaensis* it is quite clearly abaxial. Close inspection of the fruiting pedicels of the two species reveals that they are twisted about halfway along their length in *Pedicularis curvipes* but not twisted in *Pedicularis nagaensis*. In *Pedicularis curvipes* this pedicel twisting will have the effect of reversing the apparent orientation of calyx and capsule.

2. *Pedicularis nagaensis* H.L.Li, *Taiwania* 1: 86, pl. I no. 3 (1948); Yamazaki, *Acta Phytotax. Geobot.* 19: 111 (1963); Naithani, *Fl. Pls. India, Nepal & Bhutan* 317 (1990). – Type: India, Nagaland, Naga Hills, Japvo, 2970 m, ix 1935, N.L. Bor 6425 (holo DD!; iso K!).

Pedicularis curvipes auct. mult. non Hook.f. (1884); Prain, *J. Asiat. Soc. Bengal* 58(2): 275 (1889); Clarke, *J. Linn. Soc., Bot.* 25: 51 (1890); Prain, *Ann. Roy. Bot. Gard. (Calcutta)* 3: 151 (1890) p.p. quoad spec. Clarke 41334 & t. 35A f. 1–4 in toto & t. 36 (semen); Limpricht, *Repert. Spec. Nov. Regni Veg.* 20: 240 (1924) p.p. quoad spec. Assam.; Fischer, *Bull. Misc. Inform. (Kew)* 1938: 211 (1938); Kanjilal et al., *Fl. Assam* 3: 383 (1939).

Small prostrate herbs. *Stem* often branched alternately, especially above, bifariously crispate-puberulent or usually completely glabrous, grooved, hollow. *Leaves* on main stem to 1.8 × 1.5 cm, in opposite pairs but along same side of stem, petiolate, at least some of them sometimes bearing an axillary shoot bearing smaller alternate floral leaves and flowers; petiole c.15 mm long, subequalling the lamina, nearly glabrous; lamina ovate in outline, largest ones 22–27 × 21–22 mm, pinnatisect, with 2–4 pairs of opposite or subopposite, oblong-ovate to oblong-obovate, incised-serrate segments rounded at the tip; teeth of segments mucronate at tips; upper leaf surface shortly and sparsely pilosulous along veins, lower surface glabrous except for sparsely short-pilose veins and sparse white scurf, veins reticulate and darker than lamina. *Flowers* axillary to smaller, usually alternate, floral leaves along upper part of main stem and also in terminal and axillary racemes, pedicelled; terminal racemes sometimes paired, 11–12-flowered, the flowers alternate and (at least when

in fruit) without bracts; pedicels 3–4 mm long, suberect in flower, those along stem becoming decurved in fruit but those in terminal racemes remaining suberect or spreading. *Calyx* 6 × 2.5 mm, minutely eglandular-puberulent along veins otherwise glabrous, tube with anterior fissure to c. middle, 2-lobed (the lobes anterior); lobes 2 mm long, foliaceous, darker green than tube, puberulent, distinctly serrate, the lateral teeth outspread so that the whole calyx lobe is shaped like a bird's claw. *Corolla* crimson, 16 mm long; tube 10–11 mm long, cylindrical; galea c.6 mm long, beaked; beak 5 mm long, horizontal and straight, shortly 2-fid and lobulate at apex; labellum 11 × 13 mm; lobes subequal, margin not ciliate. *Stamens* inserted in the middle of the corolla tube at the top of the ovary; filaments sparsely villous. *Style* exerted. *Capsule* 8 × 4 mm, obliquely obovoid with suberect, oblique apiculus on posterior side. Seeds pinkish-purple, narrowly ellipsoid-cylindrical with basal elaiosome, c.4 × 1 mm, testa coarsely reticulate, the reticula thin-walled and rectangular to nearly square.

Distribution and ecology. India (Nagaland). Trailing over rocks in pastures, on banks, by paths; 2630–3330 m.

Flowering and fruiting. July–October(–?November); flowering beginning during the monsoon. Kanjilal *et al.* (1939) state 'Flrs. 10–11'; although there is no direct evidence of November flowering from the specimens we have seen, Clarke's (fruiting but non-flowering) specimens were collected so late in October that continuation of at least the fruiting season into November is not unlikely.

Specimens examined. NAGALAND. Naga Hills, Jakpho, 9000 ft, 25 x 1885, *C.B. Clarke* 41334A (K), 41334B (CAL); *ibid.*, 9900 ft, 25 x 1885, *C.B. Clarke* 41347 (CAL); Naga Hills, Japvo, 2970 m, ix 1935, *N.L. Bor* 6425 (DD, K; type, see above); Naga Hills, Kohima, 3330 m, 1 ix 1937, *G.K. Deka* 15623 (ASSAM). MANIPUR. Sirhoi, 2630 m, 18 vii 1948, *F. Kingdon-Ward* 17814 (BM).

Not all the information in the type citation above was given in Li's protologue; the locality, altitude and month of flowering were given by Fischer (1938), taken from the K specimen of what he called *Pedicularis curvipes* and that later became an isotype of *Pedicularis nagaensis* (though this specimen was not seen by Li). The label on the DD holotype was originally annotated, '*Pedicularis curvipes* Hook.f., flowers hitherto unknown'. The specimen bears H.L. Li's *determinavit* slip as *Pedicularis nagaensis* type, dated May 1947.

Pedicularis nagaensis is by far the 'best known' of the three species of this series, seven specimens of it (belonging to five different collections) being known to us. All but one of these, however, come from the vicinity of Kohima or Japvo in Nagaland. While examining sheets from the British Museum (BM) we found an unidentified sheet of *Kingdon-Ward* 17814 collected from Sirhoi in Manipur. After critical study it was established that this collection was of *Pedicularis nagaensis* and represents an additional locality, and extension of range, for this species. Sirhoi was one of Kingdon-Ward's principal camps during his 1948 expedition to Manipur and the

mountain there (Sirhoi Kashong) was climbed by him five times. His specimen of *Pedicularis nagaensis* was collected just at the start of the monsoon (see chapter XVI, 'Monsoon on Sirhoi', in Kingdon-Ward, 1952) and was one of three species of *Pedicularis* collected there in the period from 16 July 1948 onwards (Kingdon-Ward, 1952).

In the DD holotype, the preserved portion of the main stem includes one leaf-pair from which arise two side shoots each bearing alternate leaves with at least one of them (the longer one) also with a flower at the tip. The main stem on the holotype specimen almost seems to have been acting as an aerial stolon giving off lateral flowering axes, in an analogous manner to *Ellisiophyllum pinnatum* (Wall. ex Benth.) Makino, although in that species the stems also root at the nodes, unlike *Pedicularis nagaensis*. Similar axillary side shoots are also present on Clarke 41334A; one of them bears a minute raceme of what appear to be either flower buds, or aborted or cleistogamous flowers. In Clarke 41334A the stem terminates in a bifurcated raceme, each half bearing 11–12 capsules from which any subtending bracts have all fallen.

Most of the literature purporting to relate to *Pedicularis curvipes* in fact deals with *Pedicularis nagaensis*, either in whole or in part (see list in synonymy). There is some evidence that the Chinese *Pedicularis* specialist P.C. Tsoong might have intended to reduce *Pedicularis nagaensis* to a subspecies of *Pedicularis curvipes*. In the second part of his incompletely published 'new system' of the genus, he wrote (Tsoong, 1956a: 60), 'The monotypic [group] *Curvipes* with *Pedicularis curvipes* Hook.f. and a subspecies frequents Assam and the Sikkim Himalaya'. From the context, the 'subspecies' he mentions can only be the Assam plant, *Pedicularis nagaensis*. One further part of the papers constituting his work on his new classification system appeared (Tsoong, 1956b) but no subsequent ones have been traced and the complete formal taxonomic system of the whole genus that he envisaged appears to have remained unpublished; much of it appeared in Tsoong's treatment of *Pedicularis* for *Flora Reipublicae Popularis Sinicae* (Tsoong, 1963) but his earlier papers had worldwide scope and dealt with many species not occurring in China. Since no members of series *Curvipes* occur in China Tsoong's subspecific combination for *Pedicularis nagaensis* (if that was indeed his intention) was apparently never made and no subsequent author has considered the possibility of reducing *Pedicularis nagaensis* to subspecific rank. Although *Pedicularis curvipes* and *Pedicularis nagaensis* are distinguished from each other by more cryptic characters than those that separate *Pedicularis amplicollis* from either of them, after careful consideration we consider that *Pedicularis curvipes* and *Pedicularis nagaensis* should remain full species. Despite their superficial similarities their known distributions lie at either end of the geographical range of the series (with *Pedicularis amplicollis* in between).

3. *Pedicularis amplicollis* T.Yamaz., Acta Phytotax. Geobot. 19(4–6): 111, f. 1 no. 2 & f. 2 no. 2 (1963); Naithani, Fl. Pls. India, Nepal & Bhutan 317 (1990); Mill, Fl. Bhutan 2(3): 1214 (2001). – Type: Bhutan, Thimphu, Kyapcha Dzong, 2800 m, 4 vii 1958, S. Nakao 523 (holo KYO!).

Low herbs. *Stems* 1–3 per plant, delicate, 10–20 cm long, cylindrical, pubescent, branched, the central branch \pm erect and the laterals decumbent to prostrate. *Leaves* petiolate, those in vegetative part of stem opposite (though, at least on lateral branches, arising on same side of stem), those in flowering region alternate; petiole hairy, subequalling the lamina, those of radical leaves up to 2.5 cm long, of cauline leaves up to 1 cm long; lamina 1.5–2 \times 1–1.5 cm, hairy, pinnatipartite, with 3–5 segments on each side of blade; segments alternate, oblong, 3–7 \times 1.5–4 mm, each divided into coarsely and sharply toothed lobes. *Flowers* solitary and arising alternately in axils of upper leaves, pedicelled, 12–13 mm long; pedicels hairy, at anthesis suberect and 3–6 mm long, in young fruit 10 mm. *Calyx* tubular-campanulate, 10–12 \times 3–4 mm, densely hairy, the tube with a deep anterior (topographically posterior) fissure, 4-lobed at apex (posterior tooth absent); lobes 3–4 mm long, incised-dentate, not ciliate. *Corolla* purple, 20 mm long; tube 14 \times 2–2.5 mm, straight, longer than the calyx; galea with anther-bearing part c.5 mm long and c.3 mm broad, beaked; beak c.6 mm long, slender, incurved, glabrous, tip entire; labellum 12–13 \times 18–19 mm, margins slightly undulate and very minutely pilose, lateral lobes large, weakly undulate, middle lobe much smaller (3 \times 8 mm) and emarginate or 2-lobed at apex. *Stamens* 15 mm long, inserted in the middle of the tube; filaments pubescent almost throughout except for glabrous apex; anthers 1.8–2 \times 1 mm, oblong. *Style* c.27 mm long, stigma globose, slightly protruding from beak of galea. Immature capsule obliquely oblong, c.9 mm long, acuminate at apex. *Seeds* unknown.

Distribution and ecology. Bhutan (Thimphu district). Altitude 2800 m. No other details were given by the collector.

Flowering and fruiting. Flowering and immature capsules late June–early July; complete flowering period unknown.

One feature that Yamazaki mentioned in his protologue of *Pedicularis amplicollis* without further comment was that this species allegedly possessed a calyx with a posterior split ('tubo . . . postice fisso'). Such a condition would be extremely unusual, if not unique, in *Pedicularis* and for that reason we find it surprising that Yamazaki did not comment on it. Many species of *Pedicularis* (probably a majority worldwide although the information has never been collated) have the calyx split more or less deeply on the anterior side, and one species (*Pedicularis collettii* Prain from Myanmar; ser. *Carnosae*) has both a deep anterior cleft and a shallower posterior one (Prain, 1889, 1890). The drawing provided in Yamazaki's protologue (Yamazaki, 1963: 111, f. 2 no. 2) does not show the cleft although, comparing this drawing with the specimen and in particular the shape and symmetry of the calyx, the cleft would, in Yamazaki's drawing, be on the posterior side as he described. However, we have re-examined the type several times and have finally concluded that, on the specimen, the split is on the anterior side as in other species of *Pedicularis* although we ourselves initially thought it was posterior as Yamazaki described. It is,

of course, possible that there has been rotation or twisting through 180° of some part of the flower: either twisting of the pedicel (as occurs in *Pedicularis curvipes*; see above) or rotation of the calyx (both of which would result in a morphologically anterior but topographically posterior split), or rotation of the corolla within the calyx (which would leave the calyx split as morphologically and topographically anterior but give the illusion that it was posterior). *Calyx* rotation has not been recorded previously in *Pedicularis* but *corolla* rotation of some kind is not uncommon. Nevertheless we have failed to detect rotation or twisting of corolla, calyx or pedicel in *Pedicularis amplicollis*. We therefore conclude that Yamazaki simply made an error of interpretation concerning the position of the calyx split. In *Pedicularis curvipes* and *Pedicularis nagaensis* there is no doubt that the calyx split is in the typical, anterior position.

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