Taxonomic notes on *Picrorhiza* and *Neopicrorhiza*

Chapter 2

Introduction

The present chapter describes taxonomical aspects of species from the closely related genera *Picrorhiza* and *Neopicrorhiza*. Since the plant material used for the experiments described in this thesis was obtained as simplex, and as there are no discriminative features between the rhizomes of both species, the identity of the plant material could not directly be determined. This chapter provides a basis for the proper identification of the plant material investigated.

Picrorhiza and *Neopicrorhiza* are small genera belonging to the tribe Veroniceae of the family Scrophulariaceae. This family is, according to the taxonomical system of Cronquist, arranged in the order Scrophulariales, subclass Asteridae, class Dicotyledonae, of the Angiospermae. The genus *Picrorhiza* was considered monotypic, with as only species *P. kurrooa*, until Pennell (1943) distinguished a second species: *P. scrophulariiflora* (originally written as "*P. scrophulariaeflora*"). This new species is brought under a separate genus by Hong (1984), who named it *Neopicrorhiza scrophulariiflora*. This name has been accepted as the official name of this species (Brummit, 1992). However, several arguments are in favor of the use of the basionym *Picrorhiza scrophulariiflora* within the scope of this thesis. Firstly, most literature on this species published after 1984 sticks to this synonym. Secondly, because of their similarity, rhizomes of both species are comparable with regard to their morphology, histology, accumulated metabolites, bitterness, activity, and traditional use (Zhang *et al.*, 1965, Wang *et al.*, 1993). Thirdly, because distinguishing criteria between rhizomes of both species have not been developed so far, plant material described in publications on biological activity or constituents as referred to *P. kurrooa* and obtained from raw material suppliers might erroneously be mixed up with *P. scrophulariiflora*. Therefore, the name *Picrorhiza scrophulariiflora* is used throughout this thesis.

Discussion

Picrorhiza

The genus *Picrorhiza* and the species *P. kurrooa* appeared for the first time on a drawing published by Royle on August 24, 1835[1] in his "Illustrations of Botany" (figure 1) (Royle, 1835-1840a). Bentham described the genus and the species in his "Scrophularineae Indicae", which was published a few months later, on November 17, 1835 (Bentham, 1835). However, he wrote the species name as "*P. kurroa*", probably correcting or misspelling the name of Royle's publication. In May 1836, Royle published the text on *Picrorhiza*, and retained the species name "*P. kurrooa*" (Royle, 1835-1940b). Because Bentham was the first to give a written description of the species, the accepted species name has been "*Picrorhiza kurrooa* Bentham", or alternatively "*Picrorhiza kurrooa* Royle ex Bentham". However, according to the International Code of Botanical Nomenclature article 42, an illustration with analysis published before January 1, 1908 is acceptable as valid publication, instead of a written description or diagnosis (Greuter *et al.*, 1994). Therefore, the correct name of the species is "*Picrorhiza kurrooa* Royle".

[1] For publication dates see: Stafleu and Cowan, 1983.

Figure 1. First publication on Picrorhiza kurrooa by Royle in 1835.

Royle states that the generic name is derived from the bitter root, which is used in native medicine (Royle, 1835-1940b). In Greek, "picros" means bitter, while "rhiza" means root. The specific name is derived from "Karu", the Punjabi name of the plant, which means bitter as well (Coventry, 1927).

In 1876, Bentham and Hooker described the genus *Picrorhiza* in their "Genera Plantarum", mentioning the existence of only one species. The genus was considered monotypic until Pennell distinguished another species, based on information in Hooker's "Flora of British India" (Pennell, 1943). Hooker considered the flowers of *P. kurrooa* as dimorphic, which was so far not known in the Scrophulariaceae. He distinguished a form with long stamens and a short corolla with five sub-equal lobes, and a form with short stamens and a bilabiate corolla, of which the upper lip is longer and the lower lip consists of three shorter lobes (Hooker, 1885).

Smith and Cave collected a *Picrorhiza* species at the base of the Zemu glacier in Sikkim at 4300 meter, and identified it as *P. kurrooa* (Smith and Cave, 1911). There is a specimen at the Herbarium of the Academy of Natural Sciences of Philadelphia (PH), which was identified by Pennell as the short-stamened form described by Hooker. Furthermore, he noticed that all collections seen from the Western Himalaya are in agreement with the form having long stamens, while those from the eastern Himalaya and Yunnan correspond to the form with short stamens. Therefore, he characterized two species, one of the dry western (*P. kurrooa*), and the other of the moist eastern Himalaya (*P. scrophulariiflora*) (Pennel, 1943).

Neopicrorhiza

Based on the differences described above, and additional differences between the pollen of both species, Hong (1984) suggested to place both taxa into two distinct genera: *Picrorhiza* and *Neopicrorhiza*. Both genera are monotypic, including *P. kurrooa* and *P. scrophularii-flora*, respectively. In the former, the corolla is almost actinomorphic with a short corolla tube and five equal lobes, and with stamens about 3 times longer than the corolla (Hong, 1984). The name "*Neopicrorhiza scrophulariiflora* (Pennell) Hong" has been reserved as the official name of this species (Brummitt, 1992).

Description and distribution

A. Family Scrophulariaceae, tribe Veroniceae, genus *Picrorhiza*:
Perennial herb, usually with a long rhizome. Leaves basal and alternate. Spikes terminal. Calyx nearly equally 5-partite. Corolla 4- or 5-lobed, bilabiate with lobes more or less spreading or nearly actinomorphic. Stamens 4, inserted on corolla tube, slightly didynamous, as long as corolla or strongly exserted. Stigma capitate. Capsule turgid, tapered at top, dehiscing first septicidally and then loculicidally into 4 valves. Seeds numerous, ellipsoid; seed coat very thick, transparent and alveolate. Pollen grains spheroidal, 3-colpate, with partial or perforate tectum, the partial tectum microreticulate, colpus membrane smooth or sparsely granular.

1 Corolla 4-5 mm long, 5-lobed, and nearly actinomorphic; stamens many times longer than corolla. – *Picrorhiza* Royle

2. Corolla 9-10 mm long, 4-lobed, and bilabiate; stamens slightly didynamous, equalling corolla. – *Neopicrorhiza* Hong

1. *Picrorhiza kurrooa* Royle, Ill. Bot.: t. 71. 1835; Benth., Scroph. Ind.: 47. 1835; Benth. et Hook.f. Gen. Plant. 2: 962. 1876; Hook.f. Fl. Brit. Ind. 4: 290. 1885.

Distribution: Kashmir to Kumaon, 3000-4300 m (Pennell, 1943), Pakistan to Uttar Pradesh, 3300-4300 m (Polunin and Stainton, 1990). **Jammu & Kashmir:** Apharwat, Kashmir (Rau, 1975), Burzil Pass, *Stewart 18856, 19084*, *19224* (Pennell, 1943), Gumri, *Vir Jee 133* (Jee *et al.*, 1987), Kamri Pass (Naigund), *Inayat 25732* (Pennell, 1943), Kolohoi; Zojpal; Sonsa Nag, 10,000-13,000 ft (Coventry, 1927), Lipper Valley, northwest of Kashmir Valley (Singh and Kachroo, 1976), Mir Panzil Pass, Deosai Road, *Stewart 19945a* (Pennell, 1943), Nafran, *Stewart 12537* (Pennell, 1943), Pahlgam, *Stewart 5839, 7823*, *9278* (Pennell, 1943), Pir Panjal range; Krishan Ganga valley; upper Lidder valley (Kapahi *et al*., 1993), Pirpanjal range; Krishnaganga Valley; Upper Lidder Valley (Kapil, 1995), Simthan, Jammu (Sharma and Kachroo, 1981), Sonamarg, *Stewart 6417, 6597½* (Pennell, 1943), Tragbal, *Stewart 4618* (Pennell, 1943), Zojibal Pass, *Stewart 18234* (Pennell, 1943; **Himachal Pradesh:** Basharh: Chhit Kul, *Parmanand 1032*; Hangla Pass, *Parmanand 688*; Pieri Pass, Kinnawar, *Parmanand 521* (Pennell, 1943), Chafuwa, Talla Johar, Eastern Kumaon, 3500 m *2126* (Mehta *et al.*, 1994), Chamba and Kangra (Gammie, 1898), Chamba: Kukti Pass, *Koelz 8600* (Pennell, 1943), Chamba; Kinnaur; Kulu; Lahul; Spiti (Chowdhery and Wadhwa, 1984), Chhakinal watershed, District Kullu (Dobriyal *et al.*, 1997), Kangra (Kulu): Chandrokani, *Koelz 61*; Sumdo, *Koelz 5011* (Pennell, 1943), Lahaul; Kinnaur; Kulu; Rohru; Kangra; Pangi-Bharmour above 3500 m (Chauhan, 1988), Lahul: Dilburig, Chenab Valley, *Koelz 9917*; Kyelang, *Koelz 538* (Pennell, 1943), Manimahesh, 3300 m; Rotang Pass, 3800 m, Lahaul Spiti Forest Division (Uniyal *et al.*, 1982), Pangi valley; Birmor valley; Lahaul valley; Dauladhar valley (Kapahi *et al.*, 1993), Pangi; Bharmour; Lahaul; Kalpa; Dauladhar; Barabhangal ranges (Kapil, 1995), Rohtang slope, Lahaul-Spiti *Aswal 6517* (Aswal and Mehrotra, 1994), Rudranath Bugyal, Chamoli, Garhwal (Joshi, 1989), Satrundi, Chamba (Rau, 1975); **Uttar Pradesh:** around Agora-Dodital, Uttarkashi district (Chandra and Pandey, 1983), Bhillangna Valley, Sahasru Tal, Tehri-Garhwal 5,300 m, *Gupta RK* 330 (Gupta, 1957, 1989), Buhna, Nar Parbat, Garhwal, 3000-4500 m, *Rau MA 10271* (Rau, 1961, 1975), Damdar Valley, Tehri-Garhwal 3700 m, *Duthie 229* (Gupta, 1989), Dayara, Devkund 3300 m, *Uniyal 3994* (Uniyal, 1968), Deodi Ramani, Garhwal, *Anon 73386* (Gupta, 1989), Enroute Rupkund, Garhwal, *Bhattacharya and Mehrotra* (Gupta, 1989), Gangotri, Tehri-Garhwal 2400-5000 m, *Keshwanand 30* (Gupta, 1989), Harsil, Raithal, Sukhi, Sayara, Tehri-Garhwal 3000 m in Bhagirathi Valley, *Uniyal 3994* (Gupta, 1989), Jumnotri, Tehri-Garhwal (Rau, 1963, 1975), on the way to Yumnotri, Tehri-Garhwal 2500-3500 m, *Rau MA* (Gupta, 1989), Kedar Konta, east of Sutlej gorge (Royle, 1835-1940b), Kedar Nath; Herker Dun; Ponwali; Tali; Harsil, Garhwal Himalaya 3000-4000 m (Uniyal, 1989), Kedarkanta, Tehri-Garhwal 4300 m, *Drummond 22760* (Gupta, 1989), Kedarnath, Har-ki-dun, Ponwati, Tali, Harshil and Gangotri in Garhwal Hills (Kapil, 1995), Khaljhuni, Garhwal 2200-2500 m, cultivated (Rao and Saxena, 1994), Kidarnath, Garhwal; Gangotri, Garhwal; Kumaon hills (Kapahi *et al.*, 1993), Kumaon, alpine regions (Rawat and Pangtey, 1987), Kumaon and Garhwal, alpine regions (Joshi *et al.*, 1995), Madhari Pass, Kumaun *Strachey & Winterbottom* (Duthie, 1906, Pennell, 1943), Milam, Kumaun *Schlagintweit 9647* (Pennell, 1943), Milam, Pindari, Kumaon (Rau, 1975), Narparbat, Garhwal, 3000 m *Rau MA 10271*, *10506*, *Falconer 778* (Gupta, 1989), Pithoragarh District of Kumaon Hills (Kapil, 1995), Ponwali, Tehri-Garhwal 3300-3600 m, *Uniyal 1667*, *3843* (Gupta, 1989), Rupkund, Garhwal (Bhattacharyya, 1984), Tungnath, Garhwal, 3600 m (Nautiyal, 1988), Tungnath, Garhwal, 3300 m, *Kala and Gaur*

200 (Gupta, 1989), Valley of Flowers, Glacial Valley, Garhwal, 3800-4200 m, *Malhotra BM 4601*, *4645* (Gupta, 1989).

2. *Neopicrorhiza scrophulariiflora* Hong, Opera Bot. 75: 56. 1984 – *Picrorhiza kurrooa* auct. non Royle: Hook. Fl. Brit. Ind. 4: 290. 1885; *Picrorhiza* auct. non Royle: Pennell, Monogr. Acad. Nat. Sci. Philad. 5: 65. 1943 (as '*scrophulariaeflora*').

Distribution: Eastern Himalaya to mountains of Yunnan, 4300-5200 m (Pennell, 1943), Uttar Pradesh to Southwest China, 3600-4800 m (Polunin and Stainton, 1990). **Uttar Pradesh:** Munsiari tehsil, Pithoragarh District, Kumaon (Malhotra and Balodi, 1984), Pithoragarh District, Garhwal (Balodi, 1995), Thungnath, Uttarakhand, Garhwal, 3600 m, cultivated, *Smit 9602*; **Nepal:** Bagmati zone, Rasuwa district, Langtang (Suwal, 1993), Central Nepal (Bhattarai, 1993), Gorkha district, Central Nepal *Olsen 303* (Olsen, 1998), Gosaikunda (lake Gosainkund, lo: 08524E, la: 2802N), Langtang 4270 m *Kanai & Malla 16257* (Malla, 1976), Jaljale Himal, East Nepal: Jaljale–Tin Pokhari, 4030-4130 m, *TI9110180*; around Banduke, 4150 m, *TI9110217* (Ohba and Akiyama, 1992), Jumla district, Karnali, Western Nepal (Manandhar, 1986), Laurivinayak, Langtang 3900 m *Malla 9246* (Malla *et al.*, 1976), Murkhagari, Gorkha, Central Nepal, 4000 m, cultivated, *Smit 9601C*, Thaple Himal, 4700 m (Kihara, 1955), West Nepal: *PSW 4215*; Central Nepal: *SSW 1190*; East Nepal: *Williams 309*; *TI720508*, 3500-4800 m (Hara *et al.*, 1982); **Sikkim:** Naku Chhu, *Smith & Cave 1965** (Pennell, 1943), North Sikkim; East Sikkim* (Kapahi *et al.*, 1993), Zemu valley, Llonakh, 13,000-16,000 ft, *Smith 1343*, *Smith 1965*, *Smith 2251** (Smith and Cave, 1911; *P. scrophulariiflora* Pennell, 1943), Choktsering Chhu, north of Jongri, 4000-4200 m (Hara, 1966), Gamothang (Gopethang), 3800 m (Hara, 1966), Jongri (Dzongri), 4000 m (Hara, 1963), Jongri–Olothang (Onglakthang), 3900 m (Hara, 1966), Preig Chu–Jongri (Prek Chhu), 2200-4000 m (Hara, 1966); **Bhutan:** Bhutan, 1971 *Ramesh bedi 87, 121** (Bedi, 1971).

Distribution of both species is restricted to the Himalayan region and China. While *P. kurrooa* occurs mainly in the Western Himalaya at an altitude of 3000-4300 meters, *P. scrophulariiflora* is found mainly in the Eastern Himalaya at an altitude of 4300-5200 meters (Pennell, 1943). These findings are confirmed by most of the botanical references, which describe the occurrence of *Picrorhiza* species, as listed above. Marked locations (*) indicate inaccurate identification. The nomenclature of the collections by Smith and Cave has been corrected by Pennell (1943), while Kapahi *et al.* (1993) have not made any distinction between the two species (Kapahi, personal communication). Bedi (1971) does not include a description of the plant, and probably unaware of the existence of *P. scrophulariiflora*, he may have identified his material erroneously.

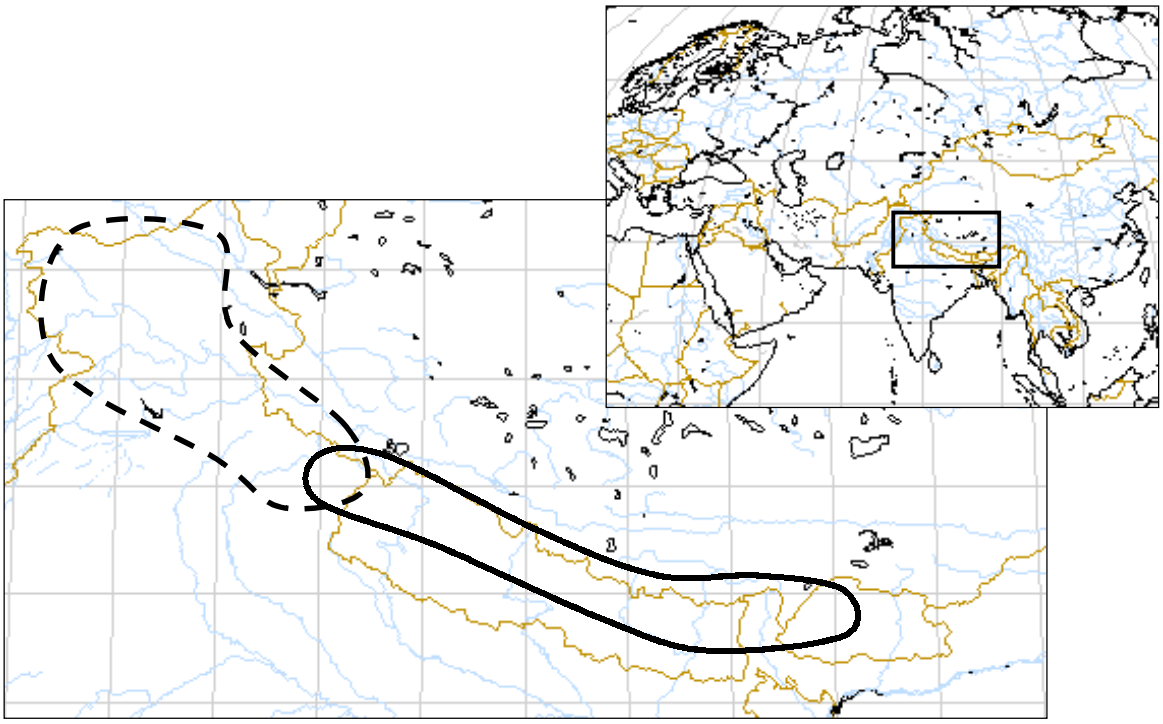

Figure 2. Distribution of Picrorhiza species in the Himalaya region: — — Picrorhiza kurrooa Royle; —— Picrorhiza scrophulariiflora Pennell.

Fieldwork

The plant material that was used for the experiments described in this thesis was purchased from Gorkha Ayurved Company, Gorkha, Nepal. To establish the identity of *Picrorhiza* species in this area, we performed fieldwork into Gorkha District, at Murkhaghari (Centre for Community Development and Research; alt. 4000 m). At this location, the exclusive presence of *P. scrophulariiflora* was observed (1996). Other observations are in agreement with the exclusive occurrence of *P. scrophulariiflora* in Gorkha District, Central Nepal (Olsen, 1998). Additional fieldwork was carried out at Thungnath, Garhwal in Uttar Pradesh, India (G.B. Pant Institute of Himalayan Environment and Development; alt. 4000 m). At this location, the presence of *P. scrophulariiflora* was observed, as identified based on the inflorescence (1996).

Except for fresh samples, market samples were obtained from different origin. Because the suppliers were generally unaware of the proper scientific names, they were asked for the origin of the material, and this information was used to establish a preliminary identity (table 1). Microscopical analysis of the material obtained from the market could not discriminate between the two species.

All identifications were done by H.F. Smit, Department of Medicinal Chemistry, Universiteit Utrecht, The Netherlands. Herbarium specimens are deposited at the National Herbarium of The Netherlands, Utrecht University Branch (U).

Table 1. Market samples obtained during fieldwork or by mail order.

Supplier	Acquired	Origin	Proposed identity
Ratna Enterprises, Colombo, Sri Lanka	1995	South India, Nepal[a]	*P. scrophulariiflora*
Nardevi, Kathmandu, Nepal	Aug. 1996	Nepal	*P. scrophulariiflora*
Laurabir, Varanasi, UP, India	Sept. 1996	Nepal	*P. scrophulariiflora*
Arya Vastu Bhandar, Dehra Dun, Garhwal, UP, India	Oct. 1996	Garhwal[b]	*P. kurrooa*
Arya Vastu Bhandar, Dehra Dun, Garhwal, UP, India	Spring 1997	Garhwal[b]	*P. kurrooa*
Jammu, JK, India	Nov. 1998	Himachal Pradesh	*P. scrophulariiflora*
Hwa To Centre, Utrecht, Netherlands	July 1999	China, Nepal[c]	*P. scrophulariiflora*

[a] According to the supplier, the material is obtained from South India, and probably originates from Nepal; [b] According to the supplier, the material originates from Garhwal, and is *P. kurrooa*; [c] Olsen (1998), in describing the trade of medicinal plants from Gorkha, notices that for several years, China purchased all *Picrorhiza* stocks from the Delhi market, being mostly *Picrorhiza* from Nepali origin. Therefore, the material probably belongs to *P. scrophulariiflora*.

Conclusion

In the present chapter, we described taxonomic aspects of the closely related species *Picrorhiza kurrooa* and *P. scrophulariiflora*. Because the plant material that was used for the experiments described in this thesis was obtained as simplex, and as there are no discriminative features between the rhizomes of both species, the plant material could not directly be identified. However, an inventory of the geographical distribution of both *Picrorhiza* species provided sufficient circumstantial evidence to establish its proper identity. The material was obtained from Gorkha Ayurved Company, Gorkha, Nepal, and originated from Gorkha District. Literature review revealed that the distribution of *P. kurrooa* is restricted to the Western Himalaya, from Kashmir to Kumaon, while *P. scrophulariiflora* is found in the Eastern Himalaya, from Garhwal to Sikkim. This observation is a strong argument to consider the identity of the Gorkha material to be *P. scrophulariiflora*. Observations by Olsen (1998) confirm the exclusive occurrence of *P. scrophulariiflora* in Gorkha District of Central Nepal. Fieldwork into Gorkha District at Murkhaghari (4000 meter) supports this conclusion, showing only the presence of *P. scrophulariiflora* in this area. In flowering season, both species can readily be distinguished, on basis of the remarkable differences in the inflorescence.

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