

## THE GENUS *ARTHRORHAPHIS* IN THE HIMALAYAS, THE KARAKORUM AND THE SUBALPINE AND ALPINE REGIONS OF SOUTH-EASTERN TIBET<sup>1</sup>

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**ABSTRACT.** The yellow coloured taxa of the genus *Arthrorhaphis* (i.e. *A. alpina* var. *alpina*, *A. alpina* var. *jungens*, *A. citrinella* and *A. vacillans*) have been revised for the Himalaya Range, the Karakorum and for the south-east Tibetan fringe-mountains. *Arthrorhaphis alpina* var. *jungens*, usually growing on sandy soil, appears to be a rather abundant lichen on open alpine (*Kobresia*-) meadows, often associated with other weakly calciphilous crusts, such as *Megaspora verrucosa*, *Phaeorrhiza nimbosea*, *Ph. sareptana*, *Psora decipiens* and several *Toninia* species. *Arthrorhaphis vacillans*, with generally similar ecological requirements, and *A. alpina* var. *alpina* in more sheltered localities, are less frequent. *Arthrorhaphis citrinella*, growing on mosses or decaying plants rather than over pure soil, is much more scarce in the study area than in the European Alps.

### INTRODUCTION

Knowledge of the lichens of the Himalayas and adjacent areas rapidly increased when the series 'Flechten des Himalaya 1–17' was published between 1966 and 1977 (for a summary of the contributions see Poelt 1977: 447). About ten years later, another series 'Beiträge zur Kenntnis der Flechtenflora des Himalaya' ('Contribution to the knowledge of the lichen flora of the Himalayas'): began, in which mainly Prof. J. Poelt (Graz, Austria) and his co-workers presented their studies on different lichen genera or interesting species, i.e. Vezda & Poelt 1988 (gyalectoid and foliicolous lichens), Poelt & Obermayer 1991 (*Bryonora*), Obermayer 1992 (*Lecanora somervellii*), Poelt & Petutschnig 1992 (*Xanthoria*, *Teloschistes*), Poelt & Grube 1992 (*Protoparmelia*), Poelt & Grube 1993a (*Tephromela*), Poelt & Grube 1993b (*Lecanora*, subg. *Placodium*), Poelt & Hinteregger 1993 (*Caloplaca*, *Fulgensia*, *Ioplaca*), Grube & Poelt 1993 (*Sporastatia*).

The present study continues this monographic treatment of lichen genera from high Asian mountains, dealing with the genus *Arthrorhaphis*, which is fairly common on the ground in the subalpine and alpine regions of south-eastern Tibet as well as the Himalayas and the Karakorum (see Fig. 1 and Fig. 2). The paper follows from a revisionary study of the genus in Europe and Greenland (Obermayer 1994).

### MATERIAL AND METHODS

About 100 specimens from the herbaria B, M and GZU have been examined with

<sup>1</sup> Lichenological results of the Sino-German-Joint-Expedition to southeastern- and eastern-Tibet 1994. I.

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a Zeiss Axioskop light microscope. Unless otherwise specified, cited material is housed in GZU. The collectors are abbreviated as follows: W.O. = Walter Obermayer; J.P. = Josef Poelt; S.G.M. = Sabine & Georg Miehe.

Nitric acid has been used either to observe the bright green colour reaction in the epithecium or for the study of young or poorly developed ascospores.

#### SOME REMARKS ON THE GENUS *Arthrorhaphis*

##### *Morphology and anatomy*

The taxa of the genus *Arthrorhaphis* are mainly characterized by the following features (for further details see Obermayer 1994): Thallus crustose (with or without the yellow colouring rhizocarpic acid), initially often parasitic on *Baeomyces* or *Dibaeis* species or on decaying lichens, rarely persistently parasitic on *Melanelia* or *Cladonia* (Santesson & Tønsberg 1994). Medulla (in *A. alpina* s.l. and *A. vacillans*) with or (in *A. citrinella*) without Ca-oxalate-crystals, sometimes hollow. Apothecia black, at least in early stages with a distinct margin. Epithecium green-brown to green-black, the colour intensifying with nitric acid. Paraphyses thin, weakly branched at the top, apices not swollen. Hymenium (or at least epithecium) with oil droplets. Asci clavate, 8-spored or sometimes with less well developed ascospores, slightly thickened at the apex, K/I-, with an ocular chamber. Ascospores colourless, cylindrical to acicular, with no perispore visible in LM, with 3–16 (rarely more) transverse septa. Conidiomata not known. Chemistry: pulvinic acid derivatives (rhizocarpic acid, epanorin), atranorin; p.p. lichen substances from the host lichen; p.p. Ca-oxalate-crystals in the medulla (in *A. alpina* s.l. and *A. vacillans*). It is striking that no *Arthrorhaphis* taxa lacking rhizocarpic acid (i.e. *A. aeruginosa*, *A. grisea*, *A. muddii*, *A. olivacea*) have been found in the material studied.

##### *Ecology*

As mentioned above, all species are able to begin life as a parasite and later become either an autonomous lichen or remain perthophytic, although in the study area, early parasitic stages were found only rarely. As pointed out in Obermayer (1994: 287), *A. alpina* s.l. and especially *A. vacillans* require weakly calcareous substrate, whereas *A. citrinella* prefers strongly acidic conditions (see below). Pintaric & Türk (1995) recently showed that the thallus size of terricolous and epiphytic foliose and fruticose lichens decreases with increasing amounts of Ca, K and Mg. This may also be true for the spore-(and ascus-)length of crustose lichens (see Obermayer 1994: 299–300).

Although themselves parasitic (at least in their early stages), all taxa of the genus *Arthrorhaphis* can also act as a host for other lichenicolous fungi. The following species have been observed on thalli of *Arthrorhaphis* (for more information including a key to the parasitic species see Hafellner & Obermayer 1995): *Cercidospora soror*, *C. trypteliza*, *Merismatium decolorans*, *Stigmidium arthrorhaphidis*.

##### *Previous reports of Arthrorhaphis species from Asia*

Recent reports of *Arthrorhaphis* species from the Himalaya Range (incl. Karakorum) are from Poelt (1961: 87), Hertel (1973: 480–482), Poelt & Hafellner (1976:

214), Poelt (1990: 434, 436) and Awasthi (1991: 48).—No species of the genus *Arthrorhaphis* has been published from Tibet (fide Wei 1991 resp. Wei & Jiang 1986). It is surprising that neither Zahlbruckner (1930, 1934) nor Magnusson (1940, 1944), although having had collections from quite rather high localities, did not note any occurrence in Asia. *Arthrorhaphis citrinella* has been reported from the Mongolian People's Republic by Schubert & Klement (1971: 211), Cogt (1979: 435; 1981: 92), Golubkova (1982 ['1981']: 66) and Bjazrov (1983: 33; 1989: 68, *A. vacillans*). For the former Soviet-Union (especially the region of North-Asia) reports for *Arthrorhaphis* taxa can be found for instance in Andreev (1982: 117; 1983: 141; 1984a: 140; 1984b: 134), Jegorova et al. (1991: 92, 108), Makarova (1983: 150; 1986: 179), Makarova & Perfiljeva (1984: 160), Obermayer (1994: 301, 319), Piin & Trass (1971: 154, 164).

#### *Difficulties with determination*

Some material proved difficult to determine even in richly fruiting specimens, often no ascospores could be found because the hymenial layer of every apothecium was completely eaten off by animals. In such cases, as well as in thalli lacking fruiting bodies, specimens have been regarded either as *A. alpina* s.l., including *A. vacillans* (when medullary Ca-oxalate-crystals are present), or as *A. citrinella* (without crystals). Soredia may occur both in *Arthrorhaphis citrinella* and *A. alpina*, thus providing no diagnostic character to separate these taxa. At the species level, it is only in *A. vacillans* that a sorediate thallus never has been observed. For further problems with determination see under the particular taxa.

#### KEY TO THE YELLOW COLOURED TAXA OF ARTHRORHAPHIS

- 1 Thallus sterile .....2
- 1\* Thallus with fruiting bodies and well developed ascospores.....3
  - 2 Thallus with a white medulla, consisting mainly of Ca-oxalate-crystals (under soredia or under a compact cortex stratum).....*Arthrorhaphis alpina* s.l. (and *A. vacillans*)
  - 2\* Thallus without a white medulla .....*Arthrorhaphis* cf. *citrinella*
- 3 Ascospores usually more than 50  $\mu\text{m}$  in length, with all spores lying at the same height in the ascus, thallus without any white medullary Ca-oxalate-crystals ... *Arthrorhaphis citrinella*
- 3\* Ascospores mostly less than 50  $\mu\text{m}$  long, usually reaching different heights in the ascus. Ca-oxalate-crystals present in the medulla .....4
  - 4 Ascospores 16–22(–25)  $\mu\text{m}$  long and mostly with 3 septa ... *Arthrorhaphis vacillans*
  - 4\* Majority of the ascospores either longer or with more septa or both (*A. alpina* s.l.)...
    - .....5
- 5 Ascospores (25–)30–50(–60)  $\mu\text{m}$  long, with 5–10(–14) septa; thallus sorediate or not ...
  - .....*Arthrorhaphis alpina* var. *alpina*
- 5\* Ascospores 18–30  $\mu\text{m}$  in length; either with 3 septa and more than 23  $\mu\text{m}$  long or shorter but then with more than 3 septa; thallus never sorediate ... *Arthrorhaphis alpina* var. *jungens*

#### TREATED TAXA

*Arthrorhaphis alpina* (Schaer.) R. Sant. in D. Hawksw., P. James & Coppins  
Lichenologist 12: 13. 1980.—*Lecidea flavo-virescens*  $\beta$  *alpina* Schaer., Lichenum Helveticorum  
Spicilegium: 162. 1833.

Thallus terricolous, muscicolous or (in early stages) lichenicolous (on *Baeomyces*, *Cladonia-squamules* or decaying lichens), (green-)yellow coloured (sometimes with a white tinge), sorediate or not, areolae plane to strongly convex (sometimes cracked and hollow at the apex). Medulla (beneath a compact cortex or under soredia) with Ca-oxalate-crystals, white or (if intermixed with rhizocarpic acid) yellow-white. Apothecia mostly with a distinct margin, disc slightly roughened. Hymenium 90–130  $\mu\text{m}$ , with a brown-green epithecium; asci (70–)80–125  $\mu\text{m}$  long. Spores up to 8 per ascus, cylindrical to slightly acicular, 3–14-septate, (16–)22–45(–60)  $\times$  3–4.5(–5)  $\mu\text{m}$ , reaching different heights in the ascus.

Comments: Features which distinguish this species from *Arthrorhaphis citrinella* are given under *A. alpina* var. *alpina*, differences from *A. vacillans* can be found under *A. alpina* var. *jungens*.

Sterile specimens examined (see Fig. 1): All specimens with Ca-oxalate-crystals in the medulla, giving it a white appearance, and no apothecia or at least no developed ascospores, no difference whether the thalli are sorediate or not, are listed here. Esorediate thalli may belong to *A. vacillans*, which is not distinguishable from *A. alpina* s.l.: CHINA, TIBET (= PROV. XIZANG), Taniantaweng Shan Mts., 60 km W of Markam (= Gartog), pass 15 km NE of Zogang (= Wangda), 29°43'N/98°00'E, 4950–5010 m alt., 4.VII.1994, W.O. (3820) – Himalaya Range, 130 km SSW of Lhasa, eastside of Puma Yumco (= Pomo Tso), way to the nearest mountain east of Pomo Tso, 28°31'N/90°37'E, alpine meadows with *Kobresia*, 5300 m alt., 15.VII.1994, W.O. (4113) – ibidem, little summit, 5770–5784 m alt., 15.VII.1994, W.O. (4114) – Himalaya Range, 120 km S of Tsetang (Nedong), 20 km S of Nera Tso (= Ni la Hu), on way to Cona (= Tsona),

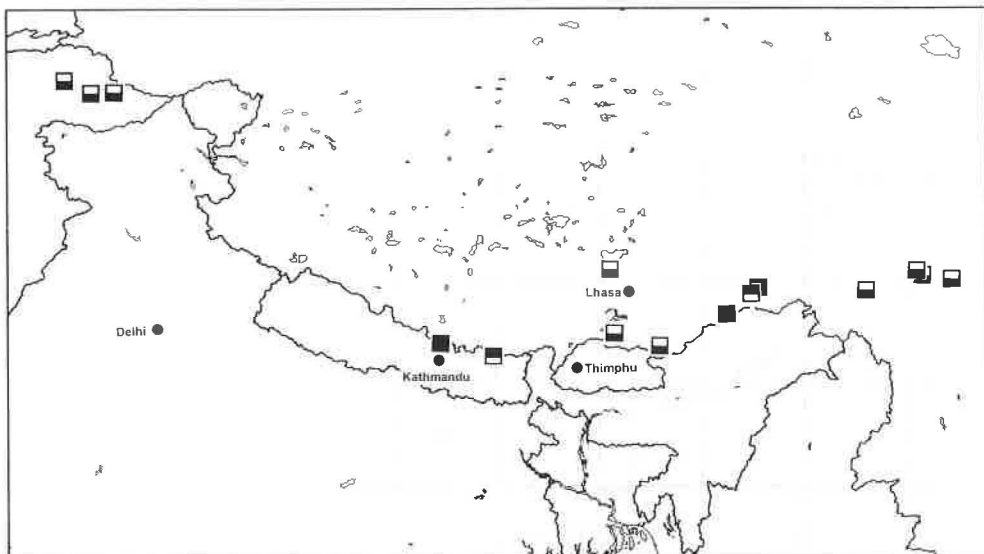


Fig. 1. Locations of examined *Arthrorhaphis* taxa in the Karakorum, the Himalayas and the mountains of south-eastern Tibet: ■ sterile *Arthrorhaphis* specimens with Ca-oxalate-crystals in the medulla (*A. alpina* s.l. and *A. vacillans*); ▨ *Arthrorhaphis citrinella*.

28°07'N/91°55'E, 4650–4800 m alt., alpine meadows, 30.VII.1994, W.O. (4100) – Himalaya Range, 280 km ESE of Lhasa, 40 km SW of Mainling, way from a mountain pasture hut (4660 m alt.) to the glacier (5100 m alt.), 29°03'N/93°56'E, 4800–5100 m alt., alpine meadows and boulders, 11.VIII.1994, W.O. (4110) (together with *A. citrinella*) – 360 km E of Lhasa, near the bend of the river Tsangpo, N-side of Gyala Peri, 10 km S of Tongjug village, W-side of the glacier, steep E-facing slope and ridge area, 29°54'N/94°51'–52'E, 4500–4700 m alt., 19.VIII.1994, W.O. (4104b) – SE-Tibet, Nyainquentanglha Shan, Yangbajain-Damxung, NW of Lhasa, S of Nyainquentanglha Feng, 30°20'N/90°34'E, 5560 m, 1989-08-13, B. Dickoré (L-02) – Himalaya, Everest-(Chomolongma-)Gruppe, zentraler Ronguk-Gletscher, orographisch rechte Flanke, 5960 m, 1984-09-24, G.M. – PROV. SICHUAN, Shalui Shan Mts., 35 km NNE of Batang, SE of Yidun, 30°16'N/99°28'E, 4200–4300 m alt., 27.6.1994, W.O. (3008) (with *Cercidospora soror* and *Stigmatidium arthrorhaphidis*) – Shalui Shan Mts., 40 km NNE of Batang, SE of Yidun, 30°14'N/99°34'E, 4700–4850 m alt., alpine meadows with *Kobresia* and *Rhododendron* shrubs, 28.VI.1994, W.O. (3573) – E of Litang, 30°07'N/100°30'E, 4200–4400 m alt., 24.VI.1994, W.O. (3153) – NEPAL, CENTRAL-NEPAL, LANGTANG-AREA, Ganja La-Nordseite, 5040 m, 1986-07-21, G.S.M. (6058) – Ganja La-Südseite, 4820 m, 1986-07-23, G.S.M. (6286) – Yala above Langtang, 4760–5120 m, 30.VI.–3.X.1986, S.G.M. (4389a, 4463, 4849a, 4944, 5230 on *Baeomyces placophyllus?*, 5418) – above Pemdang Karpo, 5240 m, 1986-10-03, G.S.M. (13282) – Surdscha Kunda Area, 5020 m, 1986-08-13, G.S.M. (8872; together with *A. vacillans*) – PAKISTAN, KARAKORUM, Baltistan, Haramosh Range, slopes between "Alm" Pakora (35°41'N/75°21'E) towards Ganto La, rocky slopes, 4100 m, Ca-haltige Erde, 1991-07-05, J.P. (K91-488,489) – Baghot Valley, 36°08'N/74°30'–42'E, 4480 m, 18.9.1990, G.S.M. (3690, 3705 with *Cercidospora trypteliza*) – Hunza und Nagar-Gebiet, Baltar-Gletscher, 4000 m, 1959, F. Lobbichler (773) (M).

#### *Arthrorhaphis alpina* var. *alpina*

This taxon is characterised by the spores, which are generally 5–10(–14) septate and (25–)30–50(–60)  $\mu\text{m}$  long and by the thallus, which consists of compact areolae or (especially over mosses) is granular-sorediate. (The presence of Ca-oxalate crystals in the medulla is typical for both varieties of *Arthrorhaphis alpina* and for *A. vacillans*.)

Comments: The length of the spores and asci in sorediate morphotypes of *A. alpina* var. *alpina* (with Ca-oxalate crystals beneath the soredia) commonly reach the upper limit of the size given, and thus come close to those of *A. citrinella*. However, the medullary crystals and the spore-arrangement in the ascus (lying not at the same height) support their inclusion in *A. alpina*. It is distinguished from *A. alpina* var. *jungens* by the septation and the length of the spores (see above).

Variety *alpina* specimens were collected between 3500 m alt. and 5500 m alt., but one sterile specimen was found at almost 5800 m (W.O. 4114). *A. alpina* var. *alpina* overgrows mosses less frequently than does *A. citrinella* and instead prefers sandy soil. It has been observed closely associated with the following lichens: *Bryonora stipitata*, *Bryoria* spec., *Cladonia* spp., *Coccocarpia* spec., *Melanelia masonii*, *Mycobilimbia* spec., *Peltigera rufescens* and *Pannaria* spec.

As mentioned under *A. citrinella*, clearly parasitic stages were rarely found. In one specimen the apothecia of *A. alpina* occur both on the typical yellow thallus and on not yellow coloured (?) *Cladonia*-squamules (W.O. 4111). Even *Diploschistes muscorum*

can have yellow coloured patches on its thallus when growing together with *Arthrorhaphis alpina* (W.O. 2921).

Fertile specimens examined (see Fig. 2): CHINA, TIBET (=PROV. XIZANG), Himalaya Range, 160 km S of Lhasa, dry valley of Kuru river, 10 km NW of Lhozag, 28°24'N/90°39'E, N-exposed steep rocks in a glen, 4230 m alt., 17.VII.1994, W.O. (4112) – 280 km E of Lhasa, 70 km E of Gongbo Gyamda, close to the shore of the lake Basum Tso, 30°00'N/93°56'–57'E, 3500 m alt., 30.VIII.1994, W.O. (4107) – 360 km E of Lhasa, near the bend of the river Tsangpo, N-side of Gyala Peri, 10 km S of Tongjug village, W-side of the glacier, near a mountain pasture hut, 29°54'N/94°52'E, 3700 m alt., 20.VIII.1994, W.O. (4105) (with *A. citrinella* on *Baeomyces*) – 350 km E of Lhasa, 20 km NE of Nyingchi, 5 km E of the pass, near the timber line, *Juniperus-Abies* forest, 29°38'N/94°42'E, 4300 m alt., 26.VIII.1994, W.O. (4111) (p.p. on (?) *Cladonia-squamules*) – Himalaya Range, 60 km ESE of Tsetang (Nedong), 30 km WSW Gyaca, way from Putrang La pass to the Tsangpo valley, 29°02'N/92°22'E, 4600 m alt., *Rhododendron* shrubs, 2.VIII.1994, W.O. (4102b) (together with *A. vacillans*) – PROV. SICHUAN, first pass between Kangding (Dardo) and Litang, 30°05'N/101°48'E, 4300 m alt., alpine meadows with *Kobresia pygmaea*, 23.VI.1994, W.O. (3109) – Shalui Shan Mts., 35 km NNE of Batang, SE of Yidun, 30°16'N/99°28'E, 4200–4300 m alt., pasture with shist outcrop and single *Juniperus* trees, 27.VI.1994, W.O. (3450) – NEPAL, CENTRAL-NEPAL, LANGTANG AREA, slopes N above Nubama Dhang, 4500 m, 1986-09-13, J.P. (N86-L743) – Upper Langtang, W Langschisa, 4590 m, 1986-09-16, G.S.M. (11978b) – slopes N above Langshisa Kharka and moraines of Shalbachun Glacier, 4400 m, 1986-09-16, J.P. (N86-L420) – huge rocks near Kyangjin, 3750 m, 1986-09-10, J.P. (N86-L1323) – Surdscha Kunda, NW exp. Felsspalten, 4730 m, 1986-08-14, G.S.M. (9006b) – Ganja La-(North), upper alpine belt, 4670 m, 1986-07-19, G.S.M. (5758) – EAST-NEPAL, KHUMBU HIMAL, Chukhung Ri, 5546 m, 1981-04-04, S. Remus & M. Menzel (060) (B, with *Cercidospora trypetheliza*).

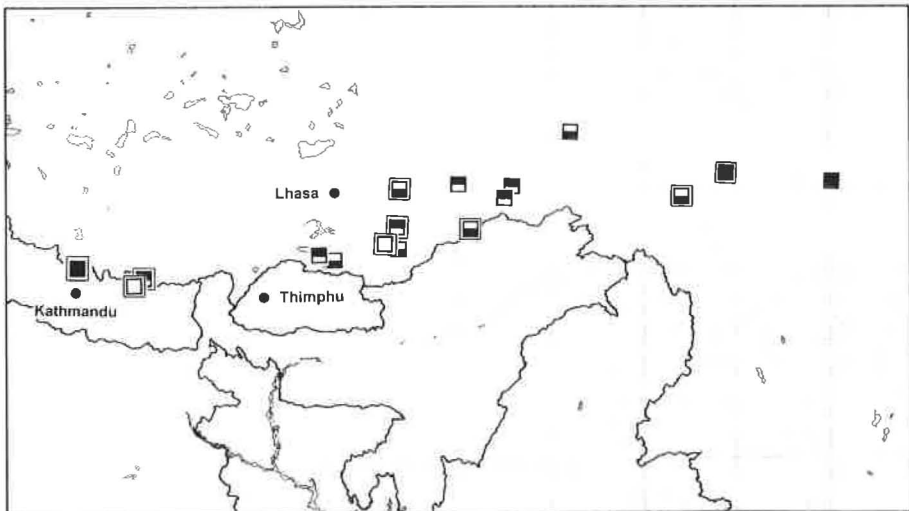


Fig. 2. Locations of examined *Arthrorhaphis* taxa in the Himalayas and the mountains of south-eastern Tibet: ■ *Arthrorhaphis alpina* var. *alpina*; ■ *Arthrorhaphis alpina* var. *jungens*; □ *Arthrorhaphis vacillans*.

*Arthrorhaphis alpina* var. *jungens* Obermayer & Poelt  
Fritschiana 3: 4. 1995.

This taxon is characterised by the non-sorediate thallus and by the spores, which are 3–6-septate, (15)18–30  $\mu\text{m}$  long, with either 3 septa and more than 23  $\mu\text{m}$  long or shorter but then with more than 3 septa (see also Obermayer 1995: 4). (The presence of Ca-oxalate crystals in the medulla is typical for both varieties of *Arthrorhaphis alpina* and for *A. vacillans*.)

Comments: As given in the description and the key, var. *jungens* differs from var. *alpina* by the non-sorediate thallus and the shorter ascospores, generally with fewer septa. *A. vacillans* has a smoother apothecial disc, and a high percentage of only 3-septate (more or less cylindrical) ascospores, reaching not more than 22  $\mu\text{m}$  in length. This taxon was first recognized by Poelt (1990: 436), whose proposed name *Arthrorhaphis vacillans* var. "*jungens*" (now *A. alpina* var. *jungens*) indicates its intermediate position (both morphologically and anatomically) between *A. vacillans* and *A. alpina*.

Although many specimens are easy to identify, some difficulties in determination (when only poorly developed ascospores are present) may occur, and it appears that the species barrier within *Arthrorhaphis* is probably rather unstable (see also Obermayer 1994: 299).

*A. alpina* var. *jungens* appears to be the most frequent taxon in the alpine regions of the high Asian mountains, spanning altitudes from 3800 to 5100 m. Commonly associated crustose lichens are: *Acarospora schleicheri*, *Baeomyces* spec., *Bryonora stipitata*, *Br. yeti*, *Caloplaca cerina* var. *muscorum*, *Candelariella* spec., *Diploschistes muscorum*, *Gypsoplaca macrophylla*, *Lecanora chondroderma*, *Megaspora verrucosa*, *Mycobilimbia lobulata*, *Phaeorrhiza nimbosea*, *Ph. sareptana*, *Psora decipiens*, *Rinodina* ssp., *Toninia* ssp.

Fertile specimens examined (see Fig. 2): CHINA, TIBET (=PROV. XIZANG), Ningjing Shan Mts., 9 km W of Markam (=Gartog), 29°40'N/98°32'E, 4200–4400 m, 1.7.1994, W.O. (3018) – way from Quamdo (Changtu) to Nagqu (=Nakchu), 31°05'N/96°10'E, 4800 m alt., 8. VII.1994, W.O. (4080) – Himalaya Range, 150 km S of Lhasa, 25 km NNW of Lhaxhang Dzong, 28°18'N/90°57'E, 3900–4300 m alt., 22.VII.1994, W.O. (2921) – Himalaya Range, 280 km ESE of Lhasa, 40 km SW of Mainling, way from a mountain pasture hut (4660 m alt.) to the glacier (5100 m alt.), 29°03'N/93°56'E, 4800–5100 m alt., alpine meadows and boulders, 11.VIII.1994, W.O. (4103) – 170 km SW of Lhasa, 110 km SSW of Tsetang (Nedong), 28°35'N/92°23'E, 4700 m alt., alpine meadows with *Kobresia pygmaea*, 26.VII.1994, W.O. (3019 with *Merismatium decolorans*, 4099) – Himalaya Range, 150 km S of Lhasa, 25 km NNW Lhaxhang Dzong, 28°18'N/90°57'E, 3900–4200 m, 22.7.1994, W.O. (3009) (with *Cercidospora soror*) – Ningjing Shan Mts., 9 km W of Markam (=Gartog), 29°40'N/98°32'E, 4200–4400 m, 1.7.1994, W.O. (3017) (with *Cercidospora trypteliza*) – 120 km E of Lhasa, Mila-Pass between Lhasa and Gongbo Gyamda, 29°51'N/92°21'E, 4950 m alt., alpine meadows, 2.IX.1994, W.O. (4108) – PROV. SICHUAN, between Kangding and Litang, 30°03'N/101°49'E, 3800–3900 m alt., *Rhododendron-Salix-Juniperus* shrubs, 23.VI.1994, W.O. (3061) – Shalui Shan Mts., 35 km NNE of Batang, SE of Yidun, 30°16'N/99°28'E, 4200–4300 m alt., pasture with shist outcrops and single *Juniperus* trees, 27.VI.1994, W.O. (3421) – NEPAL, LANGTANG AREA, Surdscha Kunda, 4840 m, 1986-08-12, G.S.M. (8771) – Karka Sarwa, 4990 m, 22.IX.1986, G.S.M. (12543, 12543b) –

slopes N of Kyangjin, moraines of Langtang Lirung Glacier, 4000–4800 m, 1986-09-09, J.P. (N 86-L795, L763, L779)–Dongga, 4700 m, 1986-09-04, G.S.M. (10677)–Langschisa, 4590 m, 1986-09-16, G.S.M. (11978, 11978a)–above Pemdang Karpo, 5090 m, 1986-10-01, G.S.M. (13227a)–Yala above Langtang, 4790–5080 m, 1986-08-08 and 1986-07-10, G.S.M. (5172, 5005)–Ganja La Southside, 4630 m, 1986-07-24, G.S.M. (6557)–slopes N above Langshisa Kharka and moraines of Shalbachun Glacier, 4500 m, 1986-09-16, J.P. (N86-L1322).

*Arthrorhaphis citrinella* (Ach.) Poelt

Bestimmungsschlüssel europäischer Flechten: 126. 1969. – *Lichen citrinellus* Ach. Kongl. vetenskaps akademien nya handlingar för månaderne Julius, Augustus, September: 135. 1795.

Thallus terricolous, muscicolous or (in early stages) lichenicolous (on *Baeomyces*, *Cladonia*-squamules or decaying lichens), (green-)yellow coloured, sorediate or not; areolae plane (sometimes slightly concave) to strongly convex and then hollow. Medullary Ca-oxalate-crystals under the cortex or at the base of the soredia absent. Apothecia with a distinct, relatively broad margin at first, later sometimes immarginate; disc roughened. Hymenium 100–140  $\mu\text{m}$ , with a green-black (to brown-green) epithecium. Asci (90–)100–140  $\mu\text{m}$  long. Spores 8 per ascus or (rarely) less, arranged within the ascus at the same height, distinctly acicular, 6–9(–14)-septate, (40–)50–100(–110)  $\times$  2,5–3,5(–4)  $\mu\text{m}$ .

Comments: *Arthrorhaphis citrinella* is characterised by having no Ca-oxalate-crystals in the medulla, by the thick marginate to immarginate fruiting bodies with a rough disc, and the long, acicular spores, which lie at the same height in the ascus. Specimens with soredia may be difficult to separate from *A. alpina* var. *alpina* (see under that taxon). – *A. citrinella* was found between 3700–5100 m alt. Contrary to the situation in the Alps, it seems to be much less abundant than *A. alpina* s.l. It is the most acidophilous species of the yellow-coloured taxa. The thallus usually overgrows mosses or small decaying plants. Sorediate morphotypes of *A. citrinella* (as well as *A. alpina* var. *alpina*) mainly grow in rather sheltered situations.

Only a few samples are obviously parasitic on *Baeomyces* thalli and bear fruiting bodies on the surface of a yellow, marginally effigurate thallus and not (as is usual) on the margin of or even beside the areolae. This laminal position of the apothecia indicates a recent attack of a host lichen (W.O. 4460). On one occasion, *Arthrorhaphis citrinella* was observed to develop out of a dead *Melanelia masonii* (W.O. 4104). – Associated crustose lichens are rare or totally missing. Foliose or fruticose lichens overgrowing the same mosses are *Melanelia masonii*, *Stereocaulon* spp. or sterile *Cladonia* species.

Fertile specimens examined (see Fig. 1): CHINA, TIBET (= PROV. XIZANG), Himalaya Range, 280 km ESE of Lhasa, 40 km SW of Mainling, 29°03'N/93°58'E, 4400–4500 m alt., 12. VIII.1994, W.O. (3014) (with *Stigmidium arthrorhaphidis*) – ibidem, way from a mountain pasture hut (4660 m alt.) to the glacier (5100 m alt.), 29°03'N/93°56'E, 4800–5100 m alt., alpine meadows and boulders, 11.VIII.1994, W.O. (4110c) (together with *A. alpina* s.l.) – 330 km E of Lhasa, near the bend of the river Tsangpo, pass between Nyingchi and Tangmai, 29°37'N/94°39'E, 4500 m alt., alpine meadows with boulders, 28.VIII.1994, W.O. (4106) – 360 km E of Lhasa, near the bend of the river Tsangpo, N-side of Gyala Peri, 10 km S of Tongjug village,



W-side of the glacier, steep E-facing slope and ridge area, 29°54'N/94°51'–52'E, 4500–4700 m alt., 19.VIII.1994, W.O. (4104) – ibidem, near a mountain pasture hut, 3700 m alt., 20.VIII.1994, W.O. (4460) (on *Bacomyces*) – NEPAL, LANGTANG AREA, Surdscha Kunda, 4700–4800 m, 11–14.VIII.1986, G.S.M. (9053, 8780, 8638a, 9053 with *Cercidospora trypetheliza*) – Ganja La (N-Flanke), 5030 m, 1986, G.S.M. (6106) – Ganja La-Südseite, 4900 m, 1986-07-29, G.S.M. (6549) – Keldang, Dupku Danda, 4450–4710 m, 27.VII.1986, G.S.M. (6820, 6866b, 6782 with *Stigmidium arthrorhaphidis*).

Sterile specimens examined (*Arthrorhaphis* cf. *citrinella*): NEPAL, CENTRAL-NEPAL, LANGTANG AREA, Ganja La-Südseite, 4950 m, 1986-07-29, G.S.M. (6508) – Surdscha Kunda, snow bed with *Potentilla microphylla*, 4780 m, 1986-08-13, G.S.M. (8807) – OST-NEPAL, Khumbakarna-Himal, Dhankuta Distr., Barun Glacier valley, Sherson, 4850 m, 21.9.1972, T. Wraber.

*Arthrorhaphis vacillans* Th. Fr. & Almqu. ex Th. Fr.

Botaniska Notiser: 107. 1867.

Thallus yellow (often with a white tinge when damaged), areolae plane to convex, never sorediate. Medulla white, always containing Ca-oxalate-crystals. Apothecia flat, with a distinct, relatively narrow margin, disc smooth, often slightly shiny. Epithecium green-brown. Hymenium 70–100 µm tall. Asci 60–100 µm. Ascospores (14–)16–22 (–25) × 3–3.5 (–4) µm, a high percentage with only 3 septa (4–5-septate spores may occur). (The presence of Ca-oxalate crystals in the medulla is typical for *A. vacillans* as well as for both varieties of *Arthrorhaphis alpina*.)

Comments: The plane, narrow-marginate, often shiny apothecia and the short, cylindrical, 3-septate spores are diagnostic for *Arthrorhaphis vacillans* (see also under *A. alpina* var. *jungens*).

Its altitudinal distribution ranges from 4000 to 5100 m a.s.l. True *A. vacillans* specimens (comparable with those from the European Alps) are less common than the intermediate form between *A. vacillans* and *A. alpina* named *A. alpina* var. *jungens*. Based on the observations of the author in the south-east Tibetan mountains and in the north-east facing Himalaya Range, *A. vacillans* as well as *A. alpina* var. *jungens* can be found mostly growing over sandy soil on rather open sites, especially in alpine *Kobresia* meadows. Whilst *A. vacillans* can spread out on quite flat areas, fertile parts of *A. alpina* s.l. carrying fruiting bodies are often restricted to steep surfaces. Commonly associated crustose lichens are in general similar to those of *Arthrorhaphis alpina* var. *jungens*.

The following localities, which include also the correct data given by Hertel (1973: 480–482) must be added to the distribution map given in Obermayer (1994: 289):

Fertile specimens examined (see Fig. 2): CHINA, TIBET (= PROV. XIZANG), 120 km E of Lhasa, "Mila-Pass", pass between Lhasa and Gongbo Gyamda, 29°51'N/92°21'E, 4950 m alt., 2. IX.1994, W.O. (2918, 3422) (with *Cercidospora trypetheliza*) – Ningjing Shan Mts., 9 km W of Markam (= Gartok), 29°40'N/98°32'E, 4200–4400 m, 1. VII.1994, W.O. (3696) – Himalaya Range, 170 km SE of Lhasa, 80 km SE of Tsetang (Nedong), 2nd pass on way from Tsetang to Lhünze, 28°38'N/92°14'E, 5000 m alt., alpine meadows and debris cones, 25. VII.1994, W.O. (3423) – Himalaya Range, 60 km ESE of Tsetang (Nedong), 30 km WSW Gyaca, Putrang La

pass, 29°02'N/92°22'E, 4800 m alt., alpine meadows, 2.VIII.1994, W.O. (4101) (together with *A. alpina* var. *alpina*)—ibidem, way from Putrang La pass to the Tsangpo valley, 4600 m alt., *Rhododendron* shrubs, 2.VIII.1994, W.O. (4102)—Himalaya Range, 280 km ESE of Lhasa, 40 km SW of Mainling, way from a mountain pasture hut (4660 m alt) to the glacier (5100 m alt.), 29°03'N/93°56'E, 4800–5100 m alt., alpine meadows and boulders, 11.VIII.1994, W.O. (4109) (p.p. on *Baeomyces*, together with *A. alpina*)—PROV. SICHUAN, Shalui Shan Mts., 35 km NNE of Batang, SE of Yidun, 30°16'N/99°28'E, 4200–4300 m pasture with shist outcrop and single *Juniperus* trees, 27.VI.1994, W.O. (3489)—NEPAL, CENTRAL-NEPAL, Langtang Area, Surdscha Kunda Area, 5020 m, 1986-08-13, G.S.M. (8872; together with *A. alpina* s.l.)—EAST-NEPAL, MAHALANGUR HIMAL, KHUMBU, Bibre, 4600 m, 1962-09-24, J.P. (L1106) (M)—S Khumzung, 4000 m, 1962-10-09, J.P. (L1105) (M)—Gorak Shep, 5120 m, 1962-09, J.P. (L1110) (M)—Lobuche, 5100 m, 1962-09-23, J.P. (L1109) (M).

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