The Tibetan silver fir

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Abstract: The silver fir (*Abies*: Pinaceae) in the Yarlung tsangpo drainage of southeast Tibet (Xizang, China) is compared with other species in ***Abies*** section ***Pseudopicea*** Hickel emend Farjon & Rushforth subsection ***Delavayianae*** Farjon & Rushforth and found to be a distinct entity. It is described as ***Abies fordei*** Rushforth sp nov.

In the 2007 Yearbook I gave an over-view of the Chinese spruces (*Picea*) with particular reference to the complex centred on *Picea likiangensis* (Franch.) E. Pritz. (Rushforth 2008). In that article I showed how the common spruce in the drainage of the Yarlung tsangpo (and its largest tributary the Po tsangpo) differs from other taxa in the *P. likiangensis* complex and made the new combination *P. linzhiensis* (W.C. Cheng & L.K. Fu) Rushforth. A second species of spruce only occurs at low altitudes in the main river valleys, and this I referred to *P. spinulosa* (Griff.) A. Henry. Of particular note is how the morphological variation of the *P. likiangensis* group is explained by, and equally provides support for, the 'Red river capture' theory expounded by Clark et al. (2004).

A similar situation exists with the genus *Abies*. A workable classification of *Abies* was presented by Aljos Farjon and myself (Farjon & Rushforth 1989) and I do not need to present the informal over-view I gave for the spruces.

The principal silver fir group in the Sino-Himalayan region is the Section *Pseudopicea* Hickel emend. Farjon & Rushforth subsection *Delavayianae* Farjon & Rushforth. The species in this subsection occur in the sub-alpine forests above the *Tsuga* zone; depending upon local conditions they are either the final forest zone before the alpine moorland or may occur with or be replaced by *Juniperus* species (as on the Nambu La), *Betula utilis* (as on the Showa La and at Soe in Bhutan), and very locally with *Larix* species. Species in this group can occur as low as 2700m (on Fan Si Pan, Vietnam, and in Northern Burma) and as high as 4400m on the Nambu La.

The species are vicariads, occupying different territories in a three dimensional world. As with all conifers they are wind pollinated. Given the 'right' conditions they will hybridise (just as the European species in section *Abies* will hybridise freely in cultivation) and two species do not generally occur in the same place. Where two taxa occur in the same area there is an altitudinal or ecological factor determining the distribution, but such events are rare. For instance on the Lijiang shan, there is the nearly glabrous *A. forrestii* Coltm.-Rog. in the lower zone, and its var. *smithii* Viguié & Gaussen, which is densely hairy and with more resinous buds, above. Var. *smithii* is treated as within *A. georgei* Orr, by W.C. Cheng & L.K. Fu, which is reasonable

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Looking east across the Rong Chu to the side valley leading to the Tara or Tra La, with forested slopes composed of *Abies fordei*, *Picea linzhiensis* and *Betula utilis*.

IF priority is given to the pubescence, but the cone and bract scale of the type are indistinguishable from those of *A. forrestii*, hence my preference to retain it there. Mostly there is a single taxon in the group in any particular locality.

The main factor which leads to speciation appears to be geographical separation of populations and time, masses of it, which is where the 'Red River Capture' theory of Clark et al. (2004) is so helpful in explaining what is going on! The next most important factor is rainfall or moisture. The revolute leaf margin, best typified by *A. delavayi* Franch., is found in the wettest localities. My opinion is that it is a mechanism to shed water, which I expounded in the 1983 Yearbook (Rushforth 1984).

The Yarlung tsangpo drainage fits one of the areas isolated by the progressive 'capture' of the former Red river. The drainage is separated on the north and western sides by the Tibetan plateau, which is now too dry for silver firs. To the east the mountain range between the Po tsangpo and the Rongto chu and thence the Lohit acts as a barrier. To the south the Himalayan ranges are a barrier, but of a different kind – the high passes are too barren for silver firs, but the inhospitability is not caused by their height, but by the climate. As noted, the volume of rain is a major influence on silver fir evolution. The selection pressures are different in the wetter southern side of the Himalayan ranges than on the drier northern side. On the passes, however, even a low pass such as the Doshong La, there is moorland, not forest. The depth of snow and

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Patrick Forde crossing a log bridge (*Picea linzhiensis*!) at Pasum tso, with saplings of *Abies* behind.

shortness of the growing season are the most likely constraints. I was amazed in 1999 when I revisited the Showa La to see at 3100m, just below our 1997 campsite, an area which had been devastated by an avalanche. The striking feature, however, was that only trees taller than 4m had been flattened; those 4m or less in height were undamaged. My conclusion is that at the time the avalanche struck, there was 4m of snow lying. The Showa La (29.51'05"N, 95.21'04"E, 4592 m) is not clear of snow in mid July and is getting covered again by early October. There is simply not a sufficiently long growing season for trees at the tops of the pass, only for alpines.

The silver fir in the Yarlung tsangpo drainage is best considered as part of one species. It has an altitudinal range from 2750m beside the chu leading down from the Showa La towards the Po tsangpo and Showa village (at *circa* 29°55'N, 95°24'E), to *c.*4400m on both east and west sides of the Nambu La (28°58'12"N, 94°15'35"E, 4640m). This is not to imply that there is ever continuous silver fir forest from 2750m up to 4400m. The range in any area is much smaller due to constraints of climate and geography. There is variation in characters such as degree of pubescence and cone size (I have measured them from 2.5cm to 11cm), but not in ways which currently lead me to recognise more than one entity.

The species does not fit the characters of the densely hairy *Abies chayuensis* W.C. Cheng & L.K. Fu from the Rongto chu and upper Lohit valleys[1], nor does it fit *Abies densa* Griff. (with somewhat revolute leaf margins) from south of the

Himalayan ridge, which are its nearest neighbours. *A. delavayi* agg. occurs in the Delei valley and *A. spectabilis* (D. Don) Spach from east Nepal westwards, but these are both quite different (*A. delavayi* in the strongly revolute leaf margins, *A. spectabilis* in the shoots with hairs in the deep groves and cones with included bract scales). It shows more similarity to *A. fabri* (Mast.) Craib subsp. *minensis* (Bordères-Rey & Gaussen) Rushforth from the Songpan area of northwest Sichuan[2] and *A. fargesii* Franch. var. *faxoniana* (Rehder & E.H. Wilson) T.S. Liu from north of Songpan, Sichuan and southern Gansu[3] but differs in the foliage, shoot and cones.

My opinion is that it represents an undescribed species.

Abies fordei Rushforth sp. nov.

Abiei fabri subsp. minensis et Abiei fargesii var. faxoniana similis in foliis pectinatim dispositis sed ab eis differt in ramulis nitidis glabris pallide-brunneis vel erythro-brunneis, in gemmis globosis brunneis valde resinosis, et in strobulis maturis cylindricis cum cuspide squamae bracteae sola exserta.

Similar to *A. minensis* Bordères-Rey & Gaussen & *A. fargesii* Franch. var. *faxoniana* (Rehder & E.H. Wilson) T.S. Liu in the pectinate arrangement of the foliage but differs in the glabrous pale brown or reddish brown shiny shoots, the globose resinous brown buds and the cylindrical cone with only the cusp of the bract scale exserted.

Description: Tree 20-40m by 0.6-1.2m bole diameter. Bark grey, smooth, becoming fissured with scaly plates. Shoots brown, reddish-brown or dull brown, smooth and usually shiny in fresh material but ridged in dried state, glabrous or lightly hairy in grooves on weak shoots, paler in second and third years. Buds globose, thickly resinous, brown, 2-4mm. Leaves arranged pectinately beneath the shoot, slightly forwards or spreading at the sides and more forward above the shoot with a parting above; 1.1-2.5cm by 0.1-0.2(-0.3)cm, linear, apex rounded, finely emarginate or pointed, grooved above with no stomata, flat in fresh material but in dried specimens margins somewhat recurved with a prominent keeled midrib; stomata in 2 greyish white or whitish bands of 4-12 rows; resin canals median in fruiting specimens, usually marginal in young trees. Cone cylindrical, 2.5-11cm by 3-4 cm, sessile or on a short peduncle of 0.5cm; rachis fusiform. Ovuliferous scales rounded triangular[4] or flabellate[5], 1.1-1.5cm by 1.0-1.5cm, exposed portion of scale hairy. Bract scales spathulate to obovate-deltoid, broader near the slightly exposed apex, margin erose, circa 1.0-1.2cm by 0.6-0.8cm; cusp 0.15-0.3cm, exserted, straight or reflexed. Seed 0.8cm by 0.2-0.3cm, light brown, wing attached to upper half of seed, 0.7-0.9cm by 0.7cm, dark brown.

China: TIBET (Xizang), lower slope of the Doshong La above Pe, 3250m, 21 x 1995, Rushforth 3433*[6] (holotype, E 00131955); ibid, 3400m, Rushforth 5123* (E);

Nyima La, descent into the Rong chu valley, 3900-4100m, 30 x 1995, Rushforth 3709* (E 00073494).
Tsela dzong, 11,000 feet, 29 v 1924, Kingdon-Ward 5713 (BM).
Taktsang, Tsari, 13,000-14,000 feet, 22 vi 1936, Ludlow & Sherriff 2198 (BM); Kyimpu, Chayul, Charme Ro, sine date, Ludlow & Sherriff 1572 (BM).

Other material:
Doshong La, 3250 m KR 3432*; 3300-3350m KR 3529; 29°30'06.5"N 94°54'02.1"E, 3550 m KR 4977.
Bidu Tsepu La, 29°29'41.5"N 94°53'51.3"E, 3600m, KR 5070.
Timpe to the Nyima La, 3300-3800 m KR 3656*, Patrick Forde 95158*; 4100m KR 3701; 29°33'36.3"N 94°50'47.8"E, 3250-3700m cone 11cm, KR 5320, KR 5340.
Rong Chu valley, Chunyima, 3100m KR 3777; 29°50'15.1"N 94°45'51.0"E, 3100-3350m KR 5953, KR 5973; Dinchung La from Talam 29°46'59.4"N 94°43'08.5"E, 3425-3775m KR 6864, KR 6872*.
Nyingshi, Sirchem La, 29°33'59.9"N 94°33'33.9"E, 4000m, KR 5937; ibid TSE TIBT 33*.
Pasum (Draksum) Tso, 3700-3800m, KR 3834, Patrick Forde 95225*.
Bago (Paku) 30°02'02.0"N 94°41'50.4"E, 3100–3300m KR 6333*; Sobhe La 30°02'12.8"N 94°43'17.1"E, 3500m KR 6359, KR 7214; Donzo La 30°00'04.4"N 94°36'24.0"E, 3700m KR 6387.
Nambu La 29°58'06.6"N 94°14'46.2"E, 4400m KR 6419.
Pome, Showa 29°53'57.2"N 95°23'56.5"E, 2750m KR 5579*; 3100–3400m 29°52'48.5"N 95°23'15.3"E KR 6045, KR 6068, KR 6069; west side 29°51.03.8"N 95°20'28.3"E, 4050m KR 6155 (shoot yellow); 29°50'49.3"N 95°19'58.3"E, 3900 m KR 6169, KR 6185, KR 6186.

Rushforth 3475 (E 00073515) from the Doshong La at 3700m has the shoots more densely hairy than in other collections and may not belong here.

Abies fordei was first introduced by seeds sent out, as *A. georgei*, by Dr Pan Chih-kang of the Chinese Academy of Forestry in 1981. This seed was sent with the data 31°N 91°E, 3400-3700m. This plots as the middle of the Tibetan plateau, north of Lhasa. I suspect it was collected from somewhere in the Yarlung tsangpo drainage. Kingdon-Ward and Ludlow & Sherriff may have introduced it in the period 1924-1947 but I have not found any record of plants raised from these trips.

The species is named after Patrick Forde, an excellent travelling companion who is sadly missed (see pp. 7-9).

The naming of the silver fir from the Yarlung Tsangpo drainage, makes a trio of well distinguished species in the Pinaceae endemic to the river system, *viz. Abies fordei*, *Picea linzhiensis* (W.C. Cheng & L.K. Fu) Rushforth and *Larix kongboensis* R.R. Mill. The larch is well distinguished from *L. griffithii* Hook. f.

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Left, young tree and ***above***, cone of *Abies fordei* from the Nyima La, Rong Chu valley.

by the short globose male cones, narrower seed cones, glabrous twigs and resinous buds; it is in cultivation from Pasum tso (KR 3795*) and from the Doshong La (KR 3431* and AC 3049*). These three species are all local endemics within much larger genera with several other species in the Sino-Himalayan region. The seeds are wind dispersed, and the local endemism of these genera suggests that they are not efficient at long distance seed dispersal. Pollen can be more widely dispersed, but pollen has to reach the seed cones when they are receptive; if climatic conditions prevent this, pollen is not an effective long-distance dispersal mechanism. This could be investigated as in conifers chloroplast and mitochrondial dna has different inheritance, one from the pollen (paternal), the other from the ovule (maternal).

The other two genera of the Pinaceae in the Yarlung tsangpo drainage are *Tsuga* and *Pinus*.

Tsuga dumosa (D. Don) Eichler is a widespread species, from eastern Nepal to northern Vietnam west of the Red River (the *Tsuga* in northern Vietnam east of the Red River is *T. chinensis* (Franch.) E.Pritz.). It is essentially a tree from the wetter southern side of the Himalaya. It occurs on the 'right' bank of the postulated historic Red river, but this may simply be because the left bank has become too dry. More importantly it is recorded in several of the isolated

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Abies fordei cones:
Top, KR3433 Doshong La, 3250m cone and ***right***, KR5123 Doshong La, 3400m cone.

areas suggested by the Red river capture hypothesis. It is unlikely that it is super efficient at seed dispersal (or why has it not crossed the Red river into north-eastern Vietnam?). A more likely explanation is that it is an extremely old species. Molecular investigation to determine whether the various parts of the range are different, and how long they have been separated from one another, would be interesting.

I have only seen *Tsuga dumosa* in Tibet on the Showa La both above Showa (29.53'57.2'N, 95.23'56.5'E, 2750m KR 5581*) and on the west side but it is also recorded in the gorge below Gyala – see the remarkable pair of photographs on page 223 of *Frank Kingdon Ward's Riddle of the Tsangpo gorges* (Cox 2001) taken 75 years apart but showing the same trees looking – just the same! I have not seen it around Tangmai (Tongmai) at the confluence of the Yigrong chu and the Po Tsangpo where the climate and altitude would appear to be suitable (*Cupressus* forest abounds here).

In *Pinus* there are three species. The most attractive is *Pinus bhutanica* Grierson, Long & C.N. Page. This occurs in the lower Tongkyuk chu down to the confluence with the Po Tsangpo, forming incredibly beautiful trees at around 2000 - 2300m. It is a five-needled pine. It occurs to the west from Arunachal Pradesh to central Bhutan, with a small isolated population in west Bhutan, from where it was named. I am not sure whether it occurs to the east

of the Siang river (the name of the Yarlung tsangpo when it enters Arunachal Pradesh); however David Long (*pers. comm*.) reports it from the Dulong in extreme western Yunnan.

More widely spread is *Pinus armandii* Franch., occurring in most of China. In the Yarlung tsangpo drainage it is found on the lower slopes of the Doshong La (KW 5882*, KR 3429*), in the Yarlung tsangpo valley above Gyala (KR 3588*), in the lower Rong chu & Tongkyuk chu valleys (KR 6340*) and in the Po Tsangpo valley below Showa, around circa 2300-3400m (KR 5561*). The trees in the Rong chu valley are particularly impressive, to 40 and 50m.

I suspect that the range of *Pinus armandii* is testament to the efficiency of its seed dispersal mechanism – the large wingless seeds suggest that it is spread by birds, and does not indicate that it has a particularly ancient distribution. However, there are some differences between the Doshong La and Gyala populations, which may repay investigation.

The only hard pine in the drainage system is *Pinus densata* Mast[7]. This occurs in the Yarlung tsangpo valley (KR 3375*) and in the Po tsangpo valley. More interesting is a small population on the south facing Northern side of Pasum tso (KR 6926). Elsewhere this is recorded in southwest Sichuan and north and west Yunnan, with a small population on the Lijiang shan at Gung Ho Ba (KR 4214*).

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References:

Clark, M. K., L. M. Schoenbohm, L. H. Royden, K. X. Whipple, B. C. Burchfiel, X. Zhang, W.Tang, E. Wang & L. Chen (2004). Surface uplift, tectonics, and erosion of eastern Tibet from large-scale drainage patterns. *Tectonics* 23: TC1006, doi:10.1029/2002TC001402.

Cox, K. (editor) (2001). *Frank Kingdon Ward's Riddle of the Tsangpo Gorges* Antique Collector's Club, Woodbridge, UK.

Farjon, A & K.D.Rushforth (1989). A classification of Abies Miller (Pinaceae). *Notes Roy. Bot. Garden Edinburgh* 46 (1): 59—79

Rushforth, K. (1984). *Abies delavayi* and *Abies fabri*. *International Dendrology Society Yearbook* 1983, 118—120

Rushforth, K. (2008). Spruces (*Picea*: Pinaceae) in the Yarlung Tsangpo drainage of southeast Tibet (Xizang, China). *International Dendrology Society Yearbook* 2007, 42—53

[1] *A. chayuensis* is not recorded in cultivation but Kingdon-Ward's 7634 probably belongs here, if it is still to be found, also KW 10997.
[2] *A. fabri* subsp. *fabri* occurs in central Sichuan
[3] *A. fargesii* var. *fargesii* also occurs in southern Gansu but also further east into Chongqing, West Hubei and West Henan.
[4] 3433
[5] 3709
[6] Numbers marked by an asterisk are in cultivation
[7] *Pinus densata* subsp. *tibetica* Businský in press