

Data Sheets on Quarantine Pests

Arceuthobium* spp. (non-European)*IDENTITY**

Name: *Arceuthobium* spp. (non-European)

Taxonomic position: Angiosperms: Viscaceae

Common names: Dwarf mistletoes (English)

Guis nains (French)

Zwergmisteln (German)

EPPQ A1 list: No. 24

EU Annex designation: I/A1

Important species are:

- ***Arceuthobium abietinum***

Name: *Arceuthobium abietinum* Engelmann ex Munz

Common names: Fir dwarf mistletoe (English)

Bayer computer code: AREAB

- ***Arceuthobium americanum***

Name: *Arceuthobium americanum* Nuttall ex Engelmann

Common names: Lodgepole pine dwarf mistletoe (English)

Bayer computer code: AREAM

- ***Arceuthobium campylopodum***

Name: *Arceuthobium campylopodum* Engelmann

Common names: Western dwarf mistletoe

Bayer computer code: ARECA

- ***Arceuthobium douglasii***

Name: *Arceuthobium douglasii* Engelmann

Common names: Douglas-fir dwarf mistletoe

Bayer computer code: AREDO

- ***Arceuthobium laricis***

Name: *Arceuthobium laricis* (Piper) St. John

Common names: Larch dwarf mistletoe

Bayer computer code: ARELA

- ***Arceuthobium minutissimum***

Name: *Arceuthobium minutissimum* J.D. Hooker

Common names: Himalayan dwarf mistletoe

Bayer computer code: AREMI

- ***Arceuthobium occidentale***

Name: *Arceuthobium occidentale* Engelmann

Common names: Digger pine dwarf mistletoe

Bayer computer code: AREOC

- **Arceuthobium pusillum**
Name: *Arceuthobium pusillum* Peck
Common names: Eastern dwarf mistletoe
Bayer computer code: AREPU
 - **Arceuthobium tsugense**
Name: *Arceuthobium tsugense*
Common names: Hemlock dwarf mistletoe
Bayer computer code: ARETS
 - **Arceuthobium vaginatum**
Name: *Arceuthobium vaginatum* (Willdenow) Presl
Common names: Southwestern dwarf mistletoe
Bayer computer code: AREVA
- There are other less important species, occurring on conifers of no significance for the EPPO region, or in more tropical areas of Central America, or simply rare and little known.

HOSTS

In the western USA and Mexico, almost all species of *Abies*, *Larix*, *Picea*, *Pseudotsuga*, *Tsuga* and 80% of *Pinus* spp. are parasitized to some degree by *Arceuthobium* spp. The few species not known to be parasitized are local endemics. These hosts are all Pinaceae. Cupressaceae and Taxodiaceae are not attacked.

Most dwarf mistletoes occur principally on one or several species of a single genus. A few are host-specific, never or hardly ever occurring on other species or genera. Others have a broader host range, more or less frequently attacking other species or genera when these occur in the vicinity of the principal hosts. In general, however, *Arceuthobium* spp. do not frequently occur on secondary hosts in the absence of principal hosts. Detailed tables of principal hosts, secondary hosts, occasional hosts and rare hosts are given by Hawksworth & Wiens (1972).

Arceuthobium spp. may attack "extra-limital" hosts, i.e. hosts that do not naturally occur within their range. These may often be in genera other than their principal hosts, so it is not easy to predict which European conifer species might be attacked by North American dwarf mistletoes. Graham & Leaphart (1961) noted in particular that plantation-grown *Pinus sylvestris* was so severely attacked by *A. laricis* in Washington that this tree should not be planted in areas where this species occurs.

The principal and other hosts of the species considered in this data sheet can be summarized as follows:

- **Arceuthobium abietinum**
 Principally on *Abies grandis* and *A. magnifica*, rarely on other genera.
- **Arceuthobium americanum**
 Principally on *P. banksiana* and *Pinus contorta*, occasionally on other *Pinus* spp., rarely on *Picea*.
- **Arceuthobium campylopodum**
 Principally on *Pinus attenuata*, *P. jeffreyi* and *Pinus ponderosa*, occasionally on other *Pinus* spp.
- **Arceuthobium douglasii**
 Principally on *Pseudotsuga menziesii*, occasionally on *Abies*, more rarely on *Picea*.
- **Arceuthobium laricis**
 Principally on *Larix occidentalis*, occasionally on *Abies*, *Picea*, *Pinus* or *Tsuga*.
- **Arceuthobium minutissimum**
Pinus wallichiana only.

- ***Arceuthobium occidentale***
Only *Pinus* spp., of which *P. radiata* is the only one of interest outside North America.
- ***Arceuthobium pusillum***
Principally *Picea mariana*, *P. glauca*, occasionally *Larix*, more rarely *Pinus*.
- ***Arceuthobium tsugense***
Principally *Tsuga heterophylla* and *T. mertensiana*, occasionally *Abies*, *Pinus* and *Picea* spp.
- ***Arceuthobium vaginatum***
Only *Pinus* spp., of which *P. ponderosa* is the only species of interest outside North America.
Distinct altitudinal zones are specific for each host/parasite combination. For more information, see also Hawksworth & Wiens (1972; 1984), Kiu (1984), Nickrent (1986).

GEOGRAPHICAL DISTRIBUTION

It is assumed (Hawksworth, 1987) that the genus originated in eastern Asia in the Eocene and migrated to the New World through the Bering area during the Oligocene. Over 80% of the known taxa occur in the New World (Hawksworth, 1987), where they occur in a zone from coastal Alaska (USA) and northern Alberta (Canada) throughout western North America into southern Mexico and Guatemala. One species only, *A. pusillum*, is found in eastern Canada and the north-central and north-eastern USA.

There is a single European species, *A. oxycedri*, occurring in central and southern Europe (extending to the Himalayas and south to Kenya) on *Juniperus communis* and other *Juniperus* spp., as well as on *Chamaecyparis thyoides*. It differs from all other species of the genus by being specific to Cupressaceae. It is of no economic importance.

EPPO region: Absent.

EU: Absent.

- ***Arceuthobium abietinum***
North America: USA (Arizona, California, Nevada, Oregon, Utah, Washington).
- ***Arceuthobium americanum***
North America: Canada (Alberta, British Columbia, Manitoba, Northwestern Territory, Ontario, Saskatchewan), USA (Alaska, California, Colorado, Idaho, Montana, Oregon, Utah, Washington, Wyoming).
- ***Arceuthobium campylopodum***
North America: Canada (British Columbia), Mexico (Baja California only), USA (Alaska, California, Idaho, Oregon, Washington).
- ***Arceuthobium douglasii***
North America: Canada (British Columbia), Mexico, USA (Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, Wyoming).
- ***Arceuthobium laricis***
North America: Canada (British Columbia), USA (Idaho, Montana, Oregon, Washington).
- ***Arceuthobium minutissimum***
Asia: Nepal, India (Jammu and Kashmir), Pakistan.
- ***Arceuthobium occidentale***
North America: USA (California).

- ***Arceuthobium pusillum***
North America: Canada (Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Quebec, Saskatchewan), USA (Connecticut, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Wisconsin).
- ***Arceuthobium tsugense***
North America: Canada (British Columbia), USA (Alaska, California, Oregon, Washington).
- ***Arceuthobium vaginatum***
North America: Mexico, USA (Arizona, Colorado, New Mexico, Texas, Utah).

BIOLOGY

From mid-summer to late autumn, seed is forcibly ejected up to 15 m in distance from mature dwarf mistletoe fruits.

Birds may be involved in long-distance dispersal. Local spread is slow but progressive, averaging 0.3-0.6 m per year. The seed coat becomes sticky after rainfall and readily adheres to foliage, and seed is transferred to twigs in rain. Here, seeds overwinter or germinate immediately, twigs less than 5 years old being most readily infected. In all species except *A. americanum*, the germinating radicle forms a holdfast when it contacts an obstruction on the host branch, such as a needle base. The holdfast develops a penetrating wedge of tissue into the host, and thus initiates the infection process. Following penetration, the remainder of the seed falls away; thus, the plant has a completely internal stage, which may last more than a year. Once inside, the mistletoe develops longitudinal and radial systems of haustoria, the former external and parallel to the host cambium and the latter oriented in the xylem and phloem. In brooms, the mistletoe appears 2-5 years after infection and flowers 1-2 years after this.

All dwarf mistletoes are dioecious, with populations usually exhibiting a 50/50 pistillate/staminate plant ratio. Insects have an important role in pollination but some wind pollination may be effected, at least over very short distances. In most species, the fruit does not mature until 5-19 months after pollination. The endophytic root system of the mistletoe survives as long as the host tissues and continuously produces new shoots unless shaded out. Dwarf mistletoe infections of roots have been reported, but these are probably a result of vegetative spread into roots from infections on the main stem near the ground-line, rather than actual infection via the roots. For more information, see Kuijt (1955), Boyce (1961), Hawksworth & Wiens (1972).

DETECTION AND IDENTIFICATION

Symptoms

Symptoms vary between and within tree species. The first external symptom is usually a swelling of the host tissues at the infection site, which eventually becomes fusiform. In the absence of mistletoe shoots, examination with a hand lens of the affected bark, or of a cross section of it, will reveal yellowish, wedge-shaped sinkers, which represent the small basal cups in which the mistletoe shoots were inserted.

Typically profuse, dense masses of distorted host branches, called witches' brooms, may develop. These are of two basic types, systemic and non-systemic. In the former, dwarf mistletoe shoots are scattered along the host branch, often concentrated at the branch girdles; in the latter, the mistletoe shoots remain concentrated near the original infection site; this type is much more common. These two types of broom are species-constant and therefore of taxonomic value. Within a host genus, the parasite and not the host determines the type of brooms formed.

Once the lower half of the tree's crown is parasitized, the growth rate declines rapidly; the height and diameter of trees is reduced, foliage yellows and becomes sparse, with a subsequent top dieback and eventual death.

For more information, see Kuijt (1955), Boyce (1961), Hawksworth (1967), Hawksworth & Wiens (1972).

Morphology

- **Arceuthobium spp.**

Shoots

Small, glabrous, variously coloured from greenish-yellow to orange, reddish and black; stems have no central vascular cylinder; leaves reduced to minute, opposed, connate scales.

Flowers

Found on young shoots, generally decussate or rarely whorled, 2-4 mm in diameter. Staminate flowers have a central nectary and three to four perianth segments, each possessing a sessile, uniloculate, circular anther; pollen spherical, with six alternating spiny and smooth sections. Pistillate flowers are epigynous, with one style, a persistent perianth and one-chambered ovary.

Fruit

An ovoid, one-seeded, mucilaginous, explosive, bicoloured berry.

- **Arceuthobium abietinum**

Plants usually over 8 cm and yellowish, little branched; staminate buds same colour as the subtending bracts.

- **Arceuthobium americanum**

Plants usually over 6 cm, with branching always whorled; fruit occurring in whorls; internodes about ten times longer than wide; staminate buds rounded.

- **Arceuthobium campylopodum**

Plants usually over 8 cm, loosely branched. Staminate spikes in summer about 5 mm long, less than three times as long as wide. On *Pinus jeffreyi*, plants are yellow; internodes 2-4 mm wide.

- **Arceuthobium douglasii**

Plants small, usually about 2 cm, generally with secondary branching.

- **Arceuthobium laricis**

Anthesis usually in August; plants 4-6 cm, flabellately branched, occurring randomly in clusters; terminal internodes of staminate shoots about 2 mm long.

- **Arceuthobium minutissimum**

The smallest known dicotyledonous plant, with aerial shoots less than 5 mm high.

- **Arceuthobium occidentale**

Resembles *A. campylopodum*.

- **Arceuthobium pusillum**

Plants very small, usually 1-3 cm high, without secondary branching.

- **Arceuthobium tsugense**

Resembles *A. campylopodum*.

- ***Arceuthobium vaginatum***

Plants large, usually over 10 cm, usually scattered along the host branch, not forming dense, globose structures; stems blackish or orange; pedicels about 3 mm; conspicuous witches' brooms on host.

Detection and inspection methods

Some dwarf mistletoes are conspicuous large parasites.

Others never grow larger than a few cm. In any case, all species initially grow within the host tissue and so cannot, at this stage, be detected with certainty by visual inspection.

MEANS OF MOVEMENT AND DISPERSAL

Seeds are short-lived and, therefore, unlikely to be important in long-distance spread of the parasite. Infected host plants are the only likely means of international spread.

PEST SIGNIFICANCE

Economic impact

Dwarf mistletoes are extremely damaging in North American forests, reducing growth rates, lowering seed production and wood quality, and even causing death. In many parts of western USA, they are considered to be the most damaging pests of conifers. A reduction in height and diameter of *Pinus contorta* of 0.7% per year and a reduction in merchantable cubic-foot volume per plot of 1.9% per year has been recorded (Hawksworth & Hinds, 1964). In 1969, it was estimated that these parasites caused a total loss of 1 billion board metres in the western USA, which, at 1970 prices, was valued at 75 million USD. For more information see Greenham & Hawksworth (1964).

Control

Since spread (by seeds) is slow, control by sanitation and modification of silvicultural practices is feasible. For *Pinus contorta*, removal of all bole-infected trees below 12.5 cm in diameter at the bole infection centre has been shown to eliminate those infections capable of spreading (Walters, 1974). In high-value areas, even chemical control may be used, but this has never been successful for most species.

The resistance of host trees to *Arceuthobium* spp. has attracted much attention. However, results of over 50 years of research indicate that host species do not apparently show useful variation in susceptibility (Scharpf, 1984; 1987).

More recently, biological control via antagonists has been investigated by various authors, but positive results have not been achieved (Scharpf, 1984; Scharpf & Koerber, 1984; Arif & Muhammad, 1986).

Phytosanitary risk

EPPO has classified non-European *Arceuthobium* spp. in general as A1 quarantine pests (OEPP/EPPO, 1980), but no other regional plant protection organization has taken an equivalent position. Though the principal hosts of the species presented in this data sheet are indigenous to North America, several are widely grown in the EPPO region (*Pinus contorta*, *P. ponderosa*, *P. radiata*, *Pseudotsuga menziesii*) and many others are grown to some extent (it is interesting to note, however, that one of the most widely grown species in Europe (*Picea sitchensis*) is only very rarely parasitized by *Arceuthobium*). Many *Arceuthobium* spp. occur on many species within a genus, and the genera concerned include major forest trees in the EPPO region (*Abies*, *Larix*, *Picea*, *Pinus*). Besides, many species occur occasionally on conifers of other genera. It is difficult to predict which of the

North American species, which are very damaging in their own natural environment, could attack and damage which species in the EPPO region. Nevertheless, there is a strong risk that introduced species would find hosts on which to multiply, and cause major damage damage in central, eastern and northern European conifer forests.

Of the species considered, *A. americanum*, *A. campylopodum*, *A. douglasii* and *A. vaginatum* seem to present the greatest risk, through the damage they cause in North America and the fact that their principal hosts are planted in the EPPO region. The Asian species *A. minutissimum* presents a distinct risk because of its different origin, but is however specific to the five-needled pine *P. wallichiana*; it is not clear that it presents a real risk for the EPPO region. The other *Arceuthobium* spp. mentioned probably present a lesser risk, and the rest of the genus a very minor risk (for the reasons given in the Identity section). However, it would in any case be difficult in practice to differentiate *Arceuthobium* spp. on imported plants, as they would most probably be immature and small.

PHYTOSANITARY MEASURES

According to the EPPO specific quarantine requirement (OEPP/EPPO, 1990), all countries should prohibit the importation of plants for planting (except seeds and tissue cultures) and cut branches of *Abies*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga* and *Tsuga* from Canada and USA, and possibly other countries where non-European *Arceuthobium* spp. occur.

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