Casuarina equisetifolia L.

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CASUARINACEAE (CASUARINA FAMILY)

Casuarina equisetifolia L. ex J.R. & G. Forst., Casuarina equisetifolia L., Casuarina litoria Rumph., Casuarina littoralis Salisb.

Australian-pine, beach she-oak, beefwood, bois de fer, casuarina, casuarine, cazuarina, cipres, coast she-oak, common ironwood, filao, filho, horsetail casuarina, horsetail-tree, pin d'Australie, pino, pino australiano, pino de Australia, sauce, she-oak, shortleaf ironwood, toa, weeping willow, whistling-pine (El-Lakany and others 1990, Little and Skolmen 1989, Little and Wadsworth 1964, National Research Council 1984a, Woodall and Geary 1985)

One of a genus of 17 species, *Casuarina equisetifolia* is native to the tropical and subtropical coastlines of Australia, Southeast Asia, Malesia, Melanesia, and Polynesia and New Caledonia. It has become pantropical as its native range expanded through introduction and naturalization (El-Lakany and others 1990, National Research Council 1984a).

Casuarina equisetifolia is a nitrogen-fixing, medium-to-large evergreen tree 15 to 30 m or more in height and up to 50 cm d.b.h. The tree has a thin crown of green, drooping branchlets that resemble pine needles. Leaves are represented as tiny teeth in whorls on the branchlets. The narrow crown of the tree becomes irregular and spreading with age. *Casuarina equisetifolia* is predominantly a coastal species and has the rare property of growing upright and symmetrical on windswept coasts. On suitable sites, *C. equisetifolia* is one of the world's fastest-growing trees. Seedlings may reach 3 m tall 1 year after planting and 8 m tall and 7 cm d.b.h. after 4 years. At age 15, plantation trees may be 17 m tall and 13 cm d.b.h. In these fast-growing plantations, mean annual increments may average 4.5 m^3 per yr (National Research Council 1984a). Occurring naturally in limestone and volcanic soils, *C. equisetifolia* thrives on loose sand a few meters from high tide as well as on infertile, red, iron-rich, leached laterite. Native stands are found along coasts at low elevations, but as an introduced species, *C. equisetifolia* grows in the tropics at elevations as high as 1500 m. Its range is restricted by freezing temperatures, although short duration, light frosts are tolerated. In the natural range of *C. equisetifolia*, annual rainfall ranges from 700 to 2000 mm, often with a dry season of 6 to 8 months. As a planted tree, it grows in areas with rainfall as little as 200 mm and as much as 5000 mm. On sand dunes in areas of low rainfall, it survives on freshwater lenses beneath the dunes (El-Lakany and others 1990, Midgley and others 1983, National Research Council 1984a).

Casuarina equisetifolia consists of two subspecies, *C. equisetifolia* spp. *equisetifolia* L. Johnson, and the smaller *C. equisetifolia* spp. *incana* (Benth.) L. Johnson. The two subspecies integrate on the Queensland coast of Australia. Genetic variation due to provenance has been demonstrated in 2- to 3-year-old trials. In China, hybrids with *C. glauca* Sieb. ex Spreng. and *C. cunninghamiana* Miq. have been produced. Also, in Florida, hybrids with *C. glauca* and possibly *C. cunninghamiana* are suspected in planted and naturalized populations. A hybrid with *C. junghuhniana* Miq. is planted in Thailand and India. (Boland and others 1984, El-Lakany and others 1990, Midgley and others 1983, Midgley and others 1986, National Research Council 1984a, Pinyopusarerk and others 1996, Woodall and Geary 1985).

The wood of *C. equisetifolia* is very dense (basic specific gravity is 0.83), difficult to saw, and splits and warps when dried. Because the wood is strong, it is used as roundwood for fencing, pilings, beams, poles, and rafters and as split wood for fencing, pilings, and roofing shingles. However, the wood is very susceptible to attack by drywood termites and is not durable in the ground. As a high-quality fuelwood that burns with great heat (5000 Kcal per kg), it has been called the best firewood in the world (Chudnoff 1984, El-Lakany and others 1990, Midgley and others 1983, National Research Council

1984a). Used extensively in windbreaks, especially in China, the trees are planted on coastal sand dunes to stabilize them. Although attractive in urban areas, *C. equisetifolia* is hazardous because it can snap or topple in hurricanes. In some regions the species is considered a nuisance because its aggressive spread disrupts native ecosystems (El-Lakany and others 1990, Midgley and others 1983, National Research Council 1984a).

Casuarina flowers are unisexual with male and female flowers that differ in appearance. Usually, male and female flowers are found on different trees, but in some regions outside its natural range *C. equisetifolia* often bears its light brown, inconspicuous, male and female flowers on the same tree. Flowering may begin as early as 2 years after seeds are sown. The wind-pollinated flowers may be borne in one or two seasonal peaks or throughout the year, depending upon the region (Boland and others 1996, Bonner 1988, Woodall and Geary 1985).

Immature fruits are greenish in color. The multiple fruits when mature are light brown, woody, warty, conelike balls 13 to 20 mm in diameter and often slightly cylindrical. Seed maturity normally occurs as the fruit turns brown. In India, seeds are mature 18 weeks after pollination. At maturity, usually September through December in the northern hemisphere, the individual fruits, each with two beak-like valves, split open to release a single, one-winged, light brown samara, 5 to 7 mm long. The species can seed prolifically at 4 years. In some tropical regions two seed crops are produced each year (Boland and others 1996, Bonner 1988).

Fruits should be brown when collected. Mature fruits can be picked by hand or shaken onto canvas sheets. In large trees, climbers collect fruits by cutting off fruiting branches and stripping the fruits later. Fruits dry and open easily in trays or on drying racks, either in the sun or in kilns. Fragments of branchlets should be removed during drying, because they are a major source of fungal infection. If dried outdoors, a thin cloth should be spread over the trays to prevent winds from blowing the seeds away. Three days of drying is adequate in India, where fruits may require insecticide treatment to repel ants (Boland and others 1996, Bonner 1988, El-Lakany and others 1990).

The mature brown seeds shake easily from open fruits and can be screened from fruit debris. Purity of 90 percent or higher is obtainable. Seed weights range from about 0.5 to 1 million or more cleaned seeds per kg. Selecting large fruits by size grading and heavy seeds by density grading gives seeds of the highest vigor. However, lack of information on the correlation between seed vigor and seedling performance suggests caution in selecting seeds solely on the basis of physical characteristics. Near-freezing or sub-freezing temperatures (-7 to 3 °C) are suitable for storage if seed moisture content is 6 to 16 percent. At ambient temperatures in the tropics, viability starts declining within 2 weeks. Low viability of freshly collected seeds has been reported in some areas (Boland and others 1996, Bonner 1988, El-Lakany and others 1990).

Seeds can be germination-tested successfully on moist media without pretreatment, but a 24-hour soak in water before testing may stimulate germination of some seed lots. Seeds treated daily to 16 hours of light at 30 °C and 8 hours of darkness at 20 °C should complete germination in 14 days. Germination tests can also be done in sand at a constant 32 °C and on filter paper at 30 °C. In addition, soaking in 1.5 percent potassium nitrate (KNO_3) and 7.5 percent calcium hypochlorite ($CaOCl_2$) for 36 hours stimulates germination (Bonner 1988, El-Lakany and others 1990, National Research Council 1984a).

Casuarina equisetifolia seedlings can be grown in containers or open beds. Bare-root seedlings can be produced in beds by broadcast sowing in the spring and covering the seeds with about 0.5 cm of soil. Watering and fertilization schedules need to be established locally, because these are dependent on the growing medium and local climate. Seedlings should be thinned to bed densities in the range of 215 to 320 seedlings per m^2. Beds may require shade in some climates. Germination should occur in 40 days and seedlings should reach plantable size of 30 to 50 cm in 3 to 4 months (Bonner 1988, National Research Council 1984a).

The success of *C. equisetifolia* as a productive plantation species depends on the roots being invaded by a variety of symbiotic organisms. Sterilized nursery soils and artificial growing media can reduce natural inoculation of roots by the symbionts. Experiments are often needed to successfully launch a new nursery. Survival and growth on nutrient-deficient sites depend on inoculation with the symbiotic filamentous bacterium, *Frankia* sp., which invades root hairs of fine roots, forming nodules. These nodules are woody and perennial and can form large masses in the root system. The atmospheric nitrogen that the *Frankia* in the nodules fixes, enables this species to grow well in soils that otherwise would be too deficient in nitrogen to sustain plant growth (El-Lakany and others 1990, Midgley and others 1983, National Research Council 1984a).

ADDITIONAL INFORMATION

The Casuarinaceae are a group of 96 species of trees and shrubs. Once all species of the family were included in a single genus, *Casuarina*. Now four genera are recognized: *Allocasuarina*, *Casuarina*, *Cuethostoma*, and *Gymnostoma*.

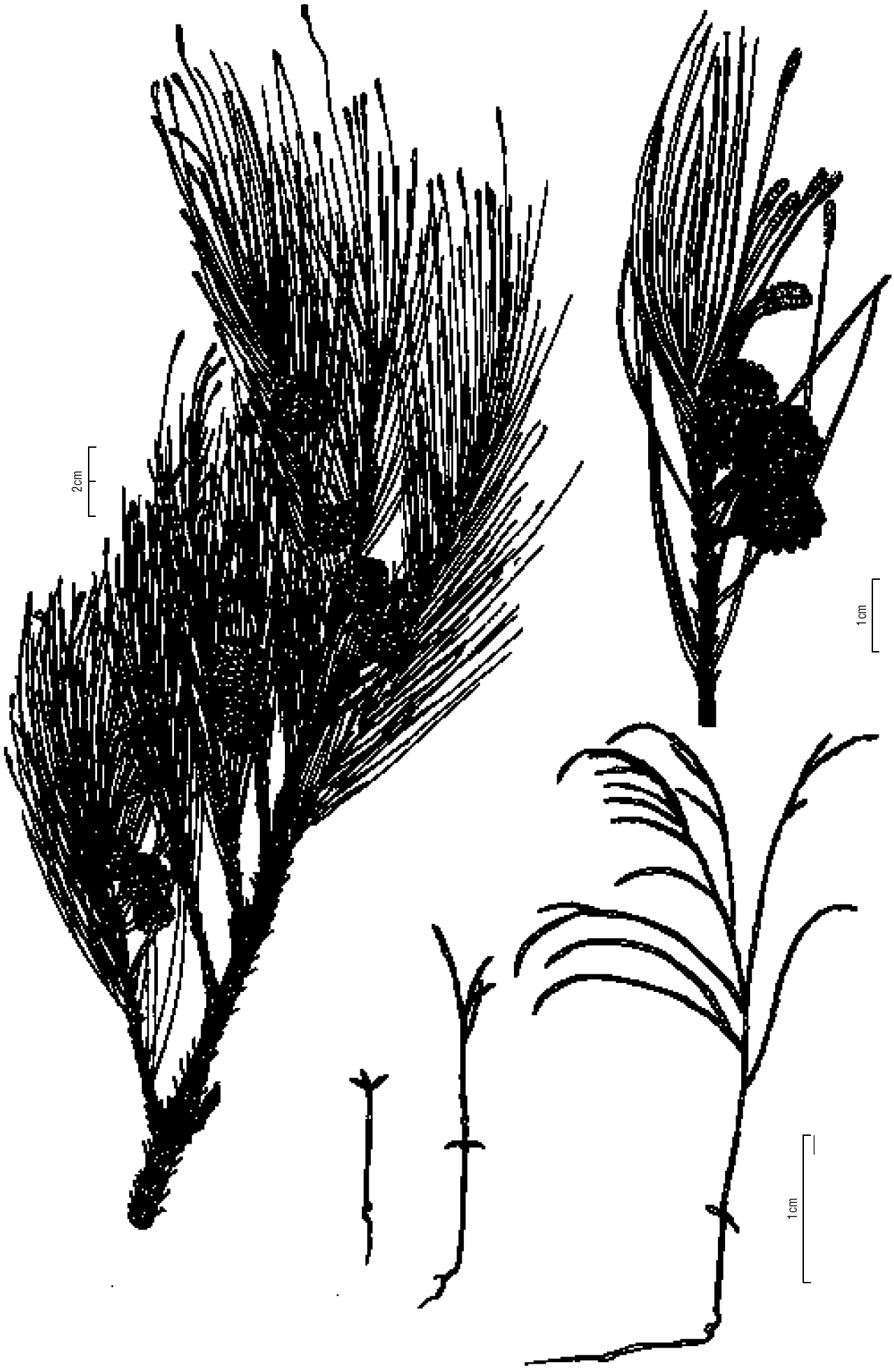
Casuarina equisetifolia often reproduces in dense stands from abundant self-seeding. However, in Puerto Rico natural regeneration is rare because ants eat the seeds (Little and Wadsworth 1964).

Male flower clusters form at the end of branchlets and resemble spikes or catkins. The clusters are narrow cylinders, 1 to 2 cm long and less than 3 mm wide. The tiny male flowers are crowded in rings among grayish scales and have one exposed brown stamen less than 3 mm long and 2 tiny brown sepal scales. The female flowers are in clusters or heads resembling short-stalked balls less than 3 mm in diameter and 8 mm across stigmas. The flower has a 5 mm long pistil, small ovary, very short style, and two long, threadlike, dark red stigmas (Boland and others 1984, El-Lakany and others 1990, Midgley and others 1983).

The *Frankia* species that forms a symbiotic relationship with species of *Casuarina* is found naturally in soils of native stands. When trees are planted outside their native range or sterile nursery soil is used, the *Frankia* might be missing and the seedlings must be inoculated. A number of inoculation techniques are used. A practical technique involves mixing surface soil from under *Casuarina* trees with bedding or container soils or mixes. In another procedure, root nodules are gathered from established trees and soaked in 70 percent ethanol for a few seconds to reduce the chance of contamination by pathogenic organisms. The nodules are washed and crushed in water; the coarser particles are then filtered out. The resulting suspension is applied to the roots of the seedlings or injected into the nursery soil. Fresh nodules can be dried over silica gel and stored for up to a year without losing their infective ability. Suspensions of ground nodules can also be stored in saline solution or in a polyvinylpyrrolidone solution (National Research Council 1984a).

Inoculation with pure cultures of *Frankia* may be the most effective means of inoculation, but it requires elaborate experimental procedures. The slow-growing filamentous bacterium is grown in liquid media. Whole cell cultures are infective whether used as liquid homogenates or as air-dried powders. Alginate beads and silica gel can be used as carriers for the inoculum. The very practical method of growing the *Frankia* in finely milled peat emulates a successful technique used for *Rhizobium* inoculation. The peat serves as a protective carrier for the *Frankia* and the medium remains infective for up to 2 years when stored at 4 °C (El-Lakany and others 1990, National Research Council 1984a, Reddell and others 1996).

Casuarinaceae also form symbiotic associations with ectomycorrhizal and endomycorrhizal fungi, which are needed for good growth in the field. The most common endomycorrhizal fungi associated with *Casuarina* sp. are in the genus *Glomus*.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