



Cassytha filiformis

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C*assytha filiformis* is, depending on one's perspective, a blessing or a bane. It is a

- plant treasured by Hawaiians for its traditional use as a light-hearted or ceremonial human ornament and in decorative garlands and lei
- valued plant in traditional societies with diverse healing applications and with promise for modern medicine
- food plant for humans and animals
- vine used in thatched roof construction
- potential biological control agent for invasive plants
- pestiferous and pathogenic weed that is a threat to agriculture and endangered plants and is capable of transmitting other pathogens between plants.

Cassytha filiformis L. is a leafless, climbing, twining, vine-like, autoparasitic and plant-hyperparasitic phanerogam (seed-bearing plant) in the plant family Lauraceae. It infests a wide variety of coastal plants throughout Hawai'i, the Pacific, and the tropics worldwide. Indigenous to Hawai'i, it is one of many higher flowering plant species that have, through evolutionary divergence, become parasitic on various organs of other higher plants. Having long ago lost certain metabolic processes and physical structures to support it and remain independent, *C. filiformis* clings to other, mainly woody, plants for physical support, nutrition, and water. Its common names are kauna'oa pehu, kauna'oa malo-lo, kauna'oa uka, kauna'oa, malolo, pololo (in Hawaiian), dodder laurel (or laurel dodder), woe vine, and love vine. This species was formerly named *Cassytha senegalensis* A. Chev. and *Cassytha guineensis* Schumach. & Thonn.

Hosts

C. filiformis parasitizes a wide variety of mainly woody hosts, including plants of agricultural and economic value, and indigenous as well as and endemic species. Among the important economic hosts are fruit plants such as citrus, mango (*Mangifera indica*), cloves (*Eugenia aromatica*), nutmeg (*Myristica fragrans*), and avocado (*Persea americana*). It also is frequently found on many other endemic tropical and subtropical species worldwide. In Hawai'i, it commonly occurs on native or naturalized woody coastal hosts such as *Tournefortia argentea* (tree heliotrope), *Scaevola sericea* (beach naupaka), *Metrosideros polymorpha* ('ōhi'a lehua), *Morinda citrifolia* (noni), *Pandanus* sp. (screw pine) and on plants surrounding these hosts, including a wide range of shrubs and herbaceous succulents, weeds, grasses, and groundcovers. According to Nickrent (2002), *C. filiformis* "appears to be totally indiscriminate in host choice, often covering and parasitizing dozens of host species simultaneously."

Genus *Cassytha*

Cassytha is a genus of about 20 species, most occurring in Australia, a few in South Africa, and one pantropical species (*C. filiformis*). The genus name derives from kesatha, Aramaic for "a tangled wisp of hair." *Cassytha* species are parasitic vines with small haustoria (infectious, adhesive structures used to withdraw nutrients from host organs through host cell membranes). Its stems are filiform, containing chlorophyll. The leaves are reduced to minute scales. The flowers are sessile or pedicellate, in heads or spicate or racemose inflorescences; the flo-

ral tubes are shallow, enveloping the fruit; there are six persistent tepals, the outer three smaller than the inner three, nine fertile stamens, those of the third whorl with two basal glands, the fourth whorl reduced to staminodia; the anthers are dithecal. The fruit is enclosed in the floral tube with a persistent perianth.

Description of *Cassytha filiformis*

Stems are green to orange, filiform, and glabrous. Leaves are reduced to minute scales, ca. 1 mm long, easiest seen near tips of stems. Flowers are sessile and few in spicate inflorescences 1(–2) cm long, each one subtended by an ovate bract and two ovate bracteoles, those with ciliolate tips; tepals are glabrous, strongly unequal, outer three ovate, ca. 1 mm long, inner three elliptic, ca. 2.5 mm long, their tips incurved; the fertile stamens are glabrous, outer 6 introrse, broad, with very short filaments acute apex, inner three extrorse, with two sessile glands at base, the tip elongated beyond anther cells into a slender beak, the fourth whorl of stamens reduced to glabrous staminodia; the ovary is globose, glabrous. Fruits are enclosed in the accrescent floral tube; dried floral parts persist in the fruiting stage.

Similar plant species

Two plant-parasitic phanerogams in Hawai'i (two *Cuscuta* species of the family Convolvulaceae, the dodders) have a similar appearance to *C. filiformis* and a similar mode of parasitism. The most readily visible features that distinguish these two genera (*Cassytha* vs. *Cuscuta*) appear in the inflorescence and the fruits (Table 1).

The flowers of *Cuscuta* are small, about 2 mm in diameter, and are borne singly along the stem. The fruit is a dry, spherical, thin-shelled structure containing several small black seeds.

The flowers of *C. filiformis* are borne in small panicles. The fruit is small, fleshy, and berry-like, bearing a single, spherical seed.

Cuscuta species are annuals, whereas *C. filiformis* is a perennial. *C. filiformis* parasitizes mainly woody plants, whereas with the exception of *Cuscuta exaltata* (not reported in Hawai'i), dodders usually parasitize herbaceous plants.

The two *Cuscuta* species in Hawai'i and *C. filiformis* are sometimes confused. In fact, they are all nowadays sometimes referred to by the same name in the Hawaiian language, kauna'oa. This fact calls into question the accuracy some of the reported host ranges found in the



Cassytha filiformis on *Metrosideros polymorpha* ('ōhi'a) on the South Kona coast, island of Hawai'i



Cassytha filiformis on noni (*Morinda citrifolia*), in the coastal Puna district, island of Hawai'i

Photos: Unless noted otherwise, photos are by S. Nelson.

Table 1. Comparison of distinguishing features for *Cassytha filiformis* and two *Cuscuta* species in Hawai'i.

	<i>Cassytha (love vine)</i>	<i>Cuscuta (dodder)</i>
Family	Lauraceae	Convolvulaceae
Stems	Green to orange	Pale yellow (<i>C. campestris</i>), or yellow to yellowish orange (<i>C. sandwichiana</i>)
Flowers	Spicate inflorescence (similar to a raceme)	Globose clusters (<i>C. campestris</i>), or cymose clusters (<i>C. sandwichiana</i>)
Growth habit	Climbing, spreading	Mainly spreading across groundcovers
Host preference	Virtually indiscriminate, tending in Hawai'i to infest woody plants (trees and shrubs), but also a parasite of a wide range of herbaceous hosts	Generally herbaceous plants. <i>C. campestris</i> favors legumes, whereas <i>C. sandwichiana</i> is not as host-specific



Flowers of *Cassytha* species (also known as “dodder laurels”) occur in spicate or racemose clusters; these plants tend to climb up and parasitize larger woody plants and shrubs.



Flowers of *Cuscuta* species (dodders) occur in cymose to globose clusters; these plants tend to spread across and parasitize herbaceous plants at ground level.

(Photo: UH-CTAHR, *Growing Plants for Hawaiian Lei*)

published literature. In Hawai'i, the three similar parasitic seed plant species are *C. filiformis* (indigenous), *Cuscuta sandwichiana* (endemic), and *Cuscuta campestris* (introduced) (Table 1).

C. filiformis has pantropical distribution throughout coastal areas; in Hawaii, it has been reported on a variety of hosts, usually growing in coastal habitats, and documented from all the major islands except Kaho'olawe. In Hawai'i, *C. filiformis* is indigenous. On Kure Atoll, (Northwestern Hawaiian Islands), a small patch was found in recent years on the northeastern coast as a parasite of *Scaevola sericea* (beach naupaka).

It inhabits coastal vegetation, usually on sandy dunes, margins of evergreen gully and riverine forests, decidu-

ous plateau and coastal woodlands, montane grasslands and dambo margins, and vegetation of sandy beaches or lakes. It grows on small bushes, woody shrubs and low trees, grasses, and herbaceous weeds.

Seeds may be spread by animals, water, strong winds, farm machinery or with crop seed. The plant may spread locally by vegetative growth between hosts and over soils. Examples of its dispersal include:

- Seeds are carried by ocean currents among and between continents and islands, or locally by streams or rivers, or seasonally flowing water.
- Seeds are consumed and dispersed by some birds.
- Seeds are dispersed by strong winds (hurricanes/typhoons).



***Cuscuta campestris* on the legume white clover (*Trifolium repens*); both species are introduced to Hawai'i.**



***Cuscuta sandwichiana* on 'ilima (*Sida falax*); both species are endemic to Hawai'i.**

- Seeds are consumed and dispersed in Australia by macropods (e.g., the Rufus Hare wallaby, *Lagorchestes hirsutus*).
- Seeds can contaminate the seed lots of other plant species and be planted unknowingly.
- Humans may disperse the plant intentionally or unintentionally.
- Tidal waves (tsunami) may move seeds and stems further inland from an original site of infestation.

Seedlings of *C. filiformis* can survive for up to two months without a host and growing to a length of 30 cm or more.

Pathogenicity of *C. filiformis* to plants

The science of plant pathology treats plant-parasitic seed plants as a distinct group of plant pathogens that are able to infect other plants and cause disease. Although many insects have a parasitic relationship with host plants, the relationship is traditionally defined as food relationship that does not develop further into a disease relationship. In a disease relationship between a parasite and host, the relations are more intimate; a process of infection ensues and the physiology and metabolism of the host is adversely affected. In this case (*C. filiformis*), disease is caused by the effect of infection of host plants by specialized attachment and penetrating feeding structures known as haustoria that are found on stems of *C. filiformis* and similar parasites.

The haustoria of *C. filiformis* penetrate the host epidermis and extend into more interior tissues, extracting cel-



***Cassytha filiformis* enshrouding and bridging noni (*Morinda citrifolia*) plants in the coastal Puna district on the island of Hawai'i.**

lular nutrients and water from plant phloem and xylem. Even though the haustorium is an intracellular structure, it is not in direct contact with the host cell cytoplasm. In the case of phloem tissues, the cells of the plant host and the pathogen are separated by their respective cell membranes. Nutrients and fluid pass through these membranes. After the haustorium directly penetrates the cell wall, the haustorium does not penetrate or break through the plasmalemma membrane, but rather invaginates it.

Teleologically, the objective of *C. filiformis* is to obtain nutrients and water from the host plant without quickly killing host cells and without interfering in more than a subtle way with their activities; the pathogen does not create immediate, fatal damage to host cells and their metabolic processes (please refer to photographs of *C.*

filiformis haustoria below). Rather, the host plants can die a long, protracted death by starvation and desiccation, while *C. filiformis*, through intimate membrane-to-membrane contact with its host and with itself, extracts what is required for it to grow, flower and produce seeds for its future generations.

Effects on host plants

Infections may be fatal. Heavy infestations can eventually smother and kill plants and their coppice re-growth in coastal habitats. *C. filiformis* is a threat to lowland reforestation projects.

C. filiformis is reported to be capable of transmitting phytoplasmas from palms [Coconut (*Cocos nucifera*); areca (areca yellow leaf disease, ALD)] and a virus dis-

ease (citrus mosaic, caused by citrus mosaic badnavirus, CiMV).

Significance of *Cassytha* worldwide

Of the 20 or so species of *Cassytha*, at least three species are locally important parasites of woody vegetation in some locations worldwide: *Cassytha ciliolata* Nees; *C. filiformis* L.; and *Cassytha melantha* R. Br. Of these, only *C. filiformis* is reported in Hawai'i. *C. filiformis* can out-compete and kill a number of endangered plants in coastal habitats in the tropics and poses a tangible threat to these endangered plants (example: *Jacquemontia recclinata* and a number of other endangered plant species in Florida and elsewhere).

Significance of *C. filiformis* in Hawai'i

C. filiformis is used in garlands and lei and is sometimes cultivated for this purpose. It is still spreading along coastal areas of Hawai'i as of 2008. It is a significant pest capable of killing native, endemic and naturalized coastal and woody plants (see below). It can damage or kill some plants of economic, cultural, or agricultural importance, including 'ōhi'a, noni, and beach naupaka. *C. filiformis* is a significant roadside eyesore in some locations; for instance, on roadside and residential plants in South Kona on the island of Hawai'i. It is a significant pest of landscape and food plants in some residential areas.

C. filiformis is a threat to endangered plants in Hawai'i; for example, it has been observed on some plants of *Euphorbia skottsbergii* var. *kalaeloana* Sherff, ('akoko, 'Ewa plains 'akoko, koko, kokomalei), which appears on the federal endangered plants list. Host plants usually succumb to heavy infestation due to a weakened condition that reduces resistance to other pests. Hand removal of the parasitic plants has been recommended (see <http://fwie.fw.vt.edu/WWW/esis/lists/e701002.htm>). In another example, *Achyranthes splendens* (common name: Maui chaff flower) is under pressing threat from the destruction of remaining habitat for development and competition from invasive plants, especially *C. filiformis*.

Measures currently being taken to protect populations of *A. splendens* and other threatened plant species in Hawai'i include weed control, conservation of plants and seeds in botanical gardens and seed banks, and preservation of remaining intact habitats.

Human practices associated with the spread and increased severity of *C. filiformis* infestations include air travel (*C. filiformis* is a common parasite around airports



Cassytha filiformis on mango (*Mangifera indica*), Hilo International Airport

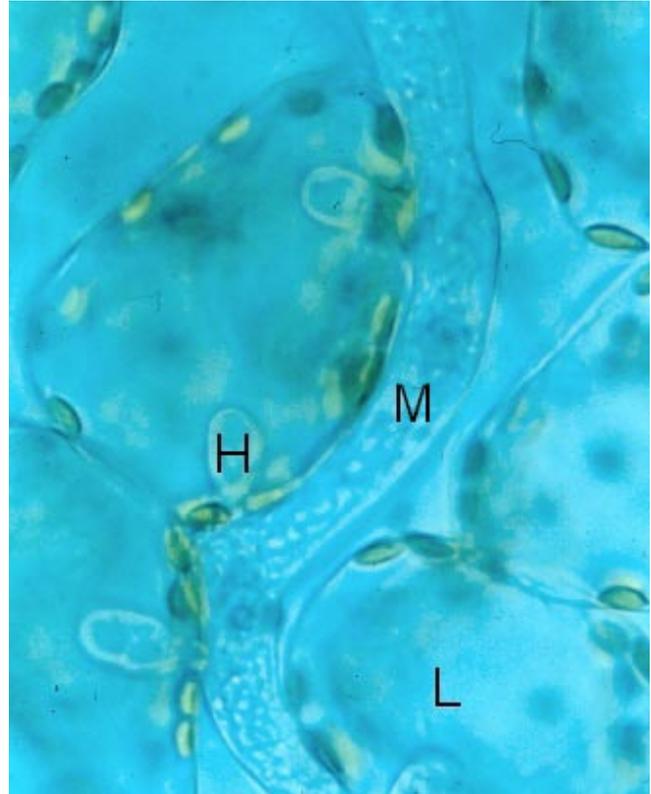
in the Pacific), bulldozing, firewood gathering, habitat modification, clearing of land and loss of shade, and increased inter- and intransland movement, which can transport seeds of invasive woody shrubs that are good hosts for *C. filiformis*.

C. filiformis is a potential biological control for invasive plants. In 2006, the Smithsonian Institute initiated a project in Florida entitled "Control of an Invasive Exotic Plant Using a Native Vine: Can the Love Vine (*C. filiformis*) Control the Spread of Brazilian Pepper (*Schinus terebinthifolius*) in Coastal Mangrove Communities?" Projects of this type should be carefully planned and monitored due to the wide host range of *C. filiformis* and the potential for spread and damage to non-target, desirable plant species.

Where the plant is cultivated or used by humans for various purposes, control of *C. filiformis* is unwarranted. However, where *C. filiformis* is regarded as a pest or weed, control is warranted, yet problematical and difficult to achieve.

Some tactics for controlling *C. filiformis*

- Remove infestations manually as early as possible to prevent further colonization and seed production (for example, inspect host plants for *C. filiformis* and prune the affected branches promptly).
- Herbicides may be available to kill the host plant or inhibit *C. filiformis*, but before applying them one should check with the Hawai'i Department of Agriculture to determine if the product and the site of application are permitted.



Haustoria. Some plant parasitic plants and plant pathogenic fungi have evolved the same mode of parasitism (haustoria), as demonstrated in this plant-fungus comparison. **Left:** A stem of the plant parasitic phanerogam, *C. filiformis*, spiraling around a woody stem in Hawai'i. The small rectangle and black arrow in the photograph indicate one of many haustoria (occurring at intervals along the stem) (Photo: Wayne Nishijima). **Right:** Haustoria of the lettuce downy mildew pathogen, *B. lactucae*, penetrating and invaginating cells of lettuce (*Lactuca sativa*) within a lettuce leaf (highly magnified,). Key: H = a bulbous haustorium, one of five or six that are visible here along the strand of fungal mycelium growing between the lettuce cells, extending from the intercellular fungal mycelium and penetrating a lettuce cell; M = intercellular fungal mycelium of the plant pathogen, *B. lactuca*; L = a lettuce cell with numerous olivine chloroplasts visible.



Left: *Cassytha filiformis* stems and haustoria on *Metrosideros polymorpha*. **Right:** An inflorescence of *C. filiformis* and haustorial attachments of stems of *C. filiformis* to other stems, demonstrating the autoparasitic nature of this plant. (Photos: J. B. Friday)



Twining habit of vine-like stems of *Cassytha filiformis* on noni (*Morinda citrifolia*); the genus name *Cassytha* derives from kesatha, Aramaic for “a tangled wisp of hair.”

- Fire is used in some locations worldwide, but this may not be permitted in Hawai'i (check with local authorities first).
- Shading can reduce the parasite's vigor (*C. filiformis* is intolerant of shade).
- Graze sheep.
- Slash clumps by hand with machete.
- Avoid planting *C. filiformis*-contaminated seed (*C. filiformis* is a prolific seed producer and seeds have a 2-month dormancy).
- Control or destroy unwanted hosts of *C. filiformis* that are adjacent to plants or crops of cultural or economic importance in order to eliminate bridges between hosts.
- Minimize coastal habitat modifications such as bulldozing, forestry operations and firewood gathering.
- Reforest lowland coastal habitats (< 300 ft elevation) to increase shade.



A severe infestation of *Cassytha filiformis* bridging several tree species, shrubs and surrounding vegetation on the South Kona coast of the island of Hawai'i

- Do not collect soil for nurseries or gardens from the vicinity of *C. filiformis*-infected plants.

Medicinal uses

In the Pacific region, *C. filiformis* is or was widely used as a medicinal plant. For example, it is used to treat jellyfish stings in Fiji. There are other reports of *C. filiformis* being used in traditional medicines in the Bahamas and the West Indies.

C. filiformis is purported to be used by several different Polynesian cultures for treatment of cancers. The plant is also used traditionally for treatment of some human birthing issues. Modern midwives recommend taking the juice made from crushed vines for 4 weeks before the expected date of birth in order to ease labor pains and to quicken labor time and lubricate the birth canal.

In Palau, bark of *Terminalia cata* (scarlet macaw, ara macao) is mixed well with a whole plant of *C. filiformis* and copra, crushed together, and the juice which is squeezed out is drunk for gonorrhea. For gonorrhea, bark from two pieces of *T. cata* stems, 2–3 cm in diameter and 7–8 cm in length, is shaved, crushed and filtered through the fibrous network of a coconut leaf-base. This is drunk with coconut milk. If a handful of *C. filiformis* is crushed and filtered and taken with water, no recurrence will reportedly take place. According to custom, the coconut shell from which copra or milk has been taken should be buried in the earth.

In modern medical research, *C. filiformis* has a number of biologically active chemical compounds with poten-



Cassytha filiformis is spreading along the roadways of the South Kona coast of the island of Hawai'i where lands have been bulldozed and developed. Here, *C. filiformis* is a parasite of 'ohi'a lehua (*Metrosideros polymorpha*) and other plants, creating an eyesore in landscapes.

tial human health applications. For instance, ocoteine, a compound isolated from *C. filiformis*, was found to be an alpha 1-adrenoceptor blocking agent in rat thoracic aorta. This type of chemistry has potential applications for inhibiting certain carcinomas such as prostate cancer. Octoeine and a number of other compounds in *C. filiformis* have antiplatelet aggregation activity.

Other uses

Among miscellaneous uses of *C. filiformis* in the Pacific region are the following:

- The plant is used for sorcery (Kiribati).
- Its fruit are used for fishing magic (Ulithi).
- The stem is used for fastening roofing (Papua New Guinea)

- The fruit is a food for children in Micronesia and as a pre-masticated food for infants (Ulithi).
- The fruit is ammunition for popguns (Puluwat).
- The sap from stems is used as shampoo and hair conditioner (Tokelau).
- The plant is used to line earthen ovens (Truk).
- The plant is used in casual head garlands for picnics and other light-hearted occasions (Hawai'i and elsewhere).
- The tips are used for scenting coconut oil (Mauru).

Notes

The term haustorium derives from the Latin word haustor, meaning "drinker." The orange stems in this species do not indicate an absence of chlorophyll; rather, the

chlorophyll is masked. The author has observed that the orange coloration of *C. filiformis* stems tends to be more pronounced in hotter, sunnier habitats than in cooler, cloudier habitats in Hawai'i. Although one common name for *C. filiformis* is "laurel dodder," it is not a true dodder as defined by the American Phytopathological Society.

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