

Diseases of Tea and Their Control in the People's Republic of China



Tzong-Mao Chen in a planting of tea bushes, with part of the Tea Research Institute in the background.

Tea, a favorite beverage of people all over the world, is made from the tender new leaves (flush) of the tea plant (*Thea sinensis* L.). In China, tea is grown generally between latitude 37° to 18° north and longitude 122° to 95° east, regions that include tropical, subtropical, and temperate zones. The warm, humid climate typical of most tea-growing areas in China plus the perennial growth habit of the tea plant provide a situation highly favorable to diseases. More than 100 diseases have been described (1) for tea plants in China. Damage to yield and quality caused by leaf, stem, and root diseases can be especially serious in the southwestern and south central regions of China (1,8,10). This article gives a brief account of the most important diseases of the tea plant in China.

Leaf Diseases

The tea planter is more concerned than growers of other crops are about leaf diseases, for the obvious reason that the

plant (bush) is cultivated for its leaves. Tea leaves are harvested several times each year, usually at intervals of 5–7 days. Only the tender new growth is picked; this is advantageous to leaf disease control because these leaves are least likely to be damaged by disease. Nevertheless, some leaf pathogens have short incubation periods, and diseases on older, more mature leaves must be controlled because these leaves represent a source of inoculum for infection of new leaves and because such diseases can reduce the productivity of a plant.

Tea blister blight caused by *Exobasidium vexans* Masee is probably the most important leaf disease of the tea plant in China. Basidiospores (primary inoculum) of this fungus are extremely sensitive to sunlight and require a high relative humidity or free water on the leaf surface to germinate. Epidemics of this disease are therefore most common at high elevations (more than 700 m) and in humid or foggy areas (1). The disease occurs every year from autumn until early spring. The percentage of infected shoots is directly related to density of basidiospores of the pathogen in the air of a tea garden. The absence of disease in the summer months in China coincides with the time when density of spores in the air is lowest, an observation similar to findings in Sri Lanka (6).

Blister blight can be controlled by application of a 0.2% nickel sulfate solution to the foliage, but this treatment is inferior to 0.5% Bordeaux mixture. The most effective control is obtained with 100 ppm of the antibiotic polyoxin, which also inhibits spread of the pathogen. A forecasting scheme proposed by DeWeille (3) in Indonesia has proved effective in Hai-Nan Island of China; by this scheme, spraying is postponed when the average daily sunshine is longer than 3.75 hours on successive days.

Japanese Exobasidium blight caused by *E. reticulatum* Ito & Sawada occurs on mature leaves and can be distinguished from blister blight by the white dustlike network of fruit bodies of the causal fungus on the underside of diseased leaves (4,8).

Anthracnose is common on mature

leaves of the tea plant. Two types occur in China: **brown blight** (Fig. 1A) caused by *Guignardia camelliae* (Cooke) Butler (asexual stage = *Colletotrichum camelliae* Masee), the most common leaf disease of tea in China (1,8), and **tea anthracnose** caused by *Gloeosporium theae-sinensis* Miyaki (8), which is most important in nurseries.

Brown blight occurs on leaves generally but on branches and fruits of tea occasionally. The pathogen overwinters in diseased leaves on the plant or fallen on the soil surface. Most infection occurs during periods of high temperature and high humidity; production and dissemination of conidial inoculum are directly correlated with rainfall, and the higher the temperature up to a maximum of 35 C, the shorter the incubation period required between inoculation and first symptoms of brown blight (Table 1). The sexual stage occurs in peak numbers during June and July (most prevalent) and again during October and November but plays no known role in overwintering of the pathogen.

In the southeastern region of China, brown blight begins in April, develops rapidly in the rainy season of May and June, and then declines during the dry season of July. The disease reappears and is often prevalent during August and early September when, over a 10-day period, the average daily temperature is higher than 28 C, total rainfall is more than 40 mm, and average relative humidity is higher than 80%. With this combination of weather factors, an outbreak of brown blight can be expected within 10–15 days. Good protection is provided by phaltan (25 WP) at 1 kg a.i./ha, 40% thiophanate-methyl at 1.1 kg a.i./ha, 100 ppm cycloheximide, 100 ppm polyoxin or chinfongmycin, or 50% benomyl at 1.4 kg a.i./ha. The chemical selected is applied 15 days before an expected disease outbreak.

Varieties with large leaves are more susceptible to brown blight than are those with small or medium-sized leaves. When inoculated artificially, leaves of two resistant varieties (Lung-Ching and Fudian Pekoe) showed a longer incubation period than leaves of two highly

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susceptible varieties (Yunan Large-leaf and Fujian Suishian) (Table 2).

Several leaf diseases of tea are caused by *Phyllosticta* spp. The five most widespread in China are: **red leaf spot** (Fig. 1B) caused by *P. theicola* Petch, **gray spot** caused by *P. dusana* Hara, **Phyllosticta leaf spot** (Fig. 1C) caused by *P. erratica* Ellis & Ev., **white scab** caused by *P. theaeifolia* Hara, and **bud blight** caused by an undescribed *Phyllosticta* sp. Red leaf spot, gray spot, and Phyllosticta leaf spot occur mainly on older, more

mature leaves as spots larger than 3 mm. Red leaf spot occurs as uniformly reddish brown to brown spots, whereas gray spot and Phyllosticta leaf spot have distinct brown margins with light-colored centers. Distinguishing gray spot and Phyllosticta leaf spot requires examination of conidia of the respective pathogens. Conidia of *P. dusana* are ellipsoid to oval and $4-5 \times 2.5-3 \mu\text{m}$; those of *P. erratica* are broad ellipsoid to globular and $6-9 \times 6-7 \mu\text{m}$. White scab and bud blight occur on buds and young leaves of tea, the former

as small circular spots and the latter as yellowish brown irregularly shaped spots or lesions on tips and margins of leaves.

Tea bud blight is a new disease, having appeared only in recent years. Damage occurs in the spring and is especially important because of symptoms on young shoots; 90% of the shoots are infected in some instances. The yellowish brown to brown lesions appear first on the tip or margin of the flush. The lesions become irregular in shape and develop dark brown elevated margins, and finally the black granular fructifications of the pathogen appear. Diseased leaves become distorted and show splitting with black-brown scorch in the leaf margin. The disease is most prevalent during late April and early May. The percentage of infection is inversely proportional to leaf age (Table 3). Average temperatures of 15–20 C are optimal for the disease; at 20 C the incubation period is only 2 or 3 days, but at 25 C no infection occurs. Infection at 20 C but not at 25 C may be the result of host predisposition caused by the lower temperatures. Bud blight can be controlled by applications of thiophanate-methyl (40 WP) at 1.1 kg a.i./ha.

Pestalozzia spp. cause at least three leaf diseases of tea in China: **gray blight** (Fig. 1D) caused by *P. theae* Sawada, **moire spot** (Fig. 1E) caused by *P. palmorum* Cooke, and a spot caused by an unidentified *Pestalozzia* sp. Gray blight is characteristically circular, with the upper surface concentrically zoned with different colors; fructifications of the pathogen are flat and occur more or less in concentric circles within the spot. Moire spot has a definite violet-brown border but no distinct zonation; conidia of the causal organism are $16-22 \times 5-7 \mu\text{m}$ and four-septate, with the three central cells pale brown and the end cells darker. Spots caused by the unidentified *Pestalozzia* sp. are light-colored and have no distinct borders.

Bird's eye spot (Fig. 1F) and **Cercospora leaf spot** are caused by *Cercospora theae* Bredde Haan and an unidentified *Cercospora* sp., respectively. Both are favored by low temperature and occur during rainy periods in spring and autumn. Bird's eye spots are circular and small, usually only 0.8–3.5 mm in

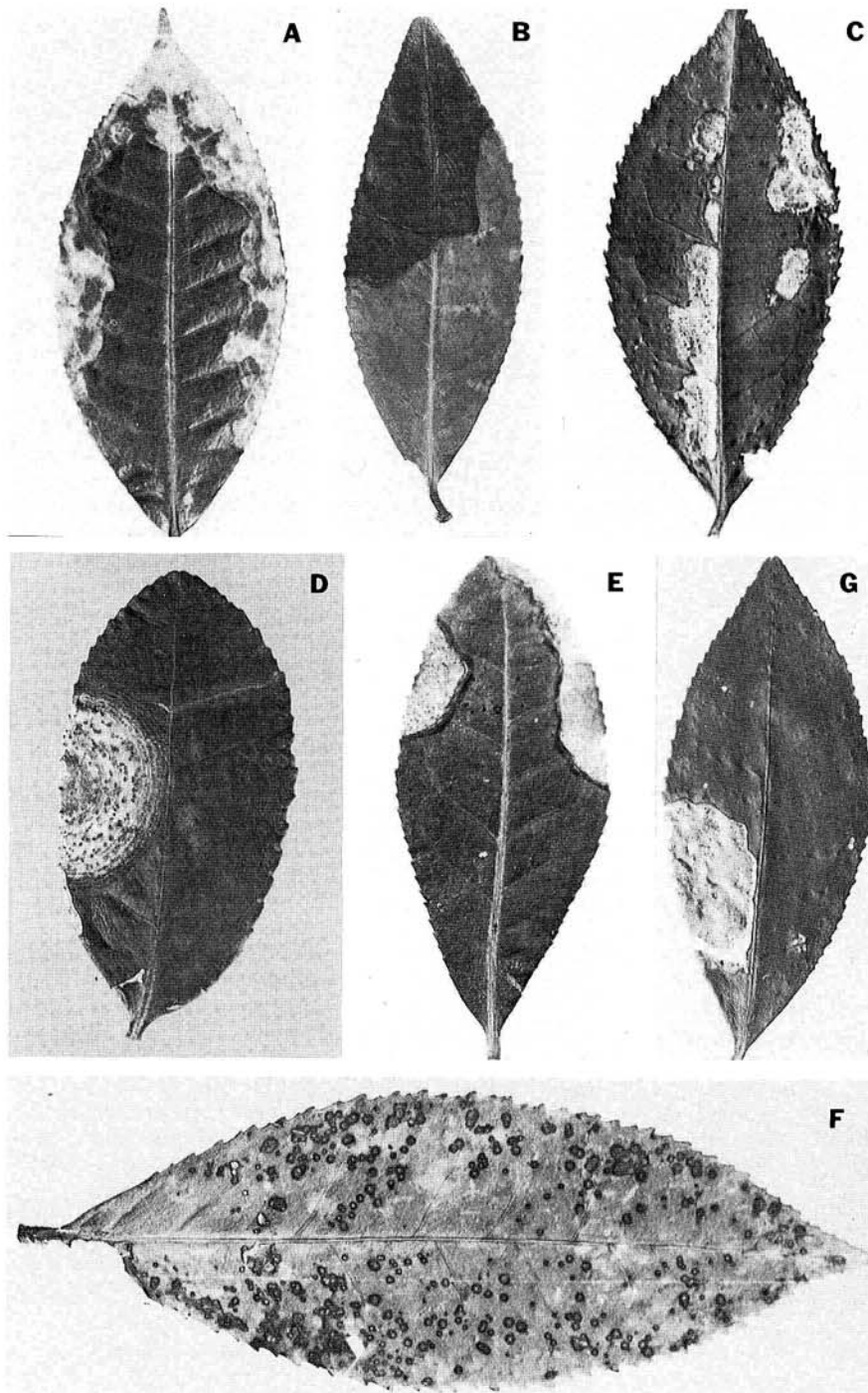


Fig. 1. Tea leaf diseases occurring in the People's Republic of China include: (A) brown blight caused by *Guignardia camelliae*, (B) red leaf spot caused by *Phyllosticta theicola*, (C) Phyllosticta leaf spot caused by *P. erratica*, (D) gray blight caused by *Pestalozzia theae*, (E) moire spot caused by *Pestalozzia palmorum*, (F) bird's eye spot caused by *Cercospora theae*, and (G) *Discosia* leaf spot caused by *Discosia theae*.

Table 1. Relationship between temperature and incubation period for brown blight caused by *Guignardia camelliae*

Average	Temperature (C)		Incubation period (days)
	Maxi-mum	Mini-mum	
16	25	14	13
16–20	26	15	11–13
20–24	28	17	10–12
24–30	35	20	5–9

Table 2. Influence of tea variety on incubation period for brown blight caused by *Guignardia camelliae*

Tea variety	Degree of resistance to brown blight	Incubation period (days)
Yunan Large-leaf	Highly susceptible	4-6
Fujian Suishian	Highly susceptible	5-7
Chouye	Medium susceptible	6-8
Zhenghou	Medium susceptible	6-9
Jue-Kon	Medium susceptible	7-9
Yutan Mountain Large-leaf	Medium susceptible	7-11
Fudian Pekoe	Resistant	9-11
Lung-Ching	Resistant	7-14

Table 3. Influence of leaf maturity on susceptibility to tea bud blight caused by unidentified *Phyllosticta* sp.

Leaf type	Infection (%)
First	43.5
Second	17.4
Third	4.3
Fish	13.0
Scar	4.3
Mature	0.0
Old	0.0

diameter, and occur on shoots and mature leaves. *Cercospora* leaf spots are larger and more irregularly shaped, occur mainly on older mature leaves, and cause defoliation.

Discosia leaf spot (Fig. 1G) caused by *Discosia theae* Cavara is prevalent during rainy weather and may cause considerable loss of yield in some years but usually is not important.

Stem Diseases

More than 20 stem diseases of the tea bush are recorded for China (1,8,10). In general, the older or less vigorous the bush, the greater the damage from stem diseases. Lichens and mosses (Table 4) are especially common on weakened bushes under humid, shaded conditions.

Corticium spp. cause two common black rot stem diseases of tea in southern China: **sclerotium black rot** caused by *C. invisum* Petch and **thread black rot** caused by *C. theae* Benard. With sclerotium black rot, the pathogen grows from infected stems via the leaf petioles to the undersides of the leaves, where it spreads fanwise. Dead branches and leaves usually remain attached to the bush. *C. invisum* overwinters as sclerotia and *C. theae*, as mycelial strands. Both pathogens are controlled by chemicals: 200 ppm of chinfongmycin, chlorothalonil (Daconil 50 WP) at 2.2 kg a.i./ha, or thiophanate-methyl (40 WP) at 1.1 kg a.i./ha. These materials are usually superior to copper fungicides. Control lasts 20-30 days.

Red rust of the tea bush is caused by *Cephaleuros parasiticus* Karst., an aggressive, intercellular, parasitic alga (1,7,8). The name "red rust" is unfortunate because the causal organism is not a rust fungus. Consequently, in China the name "red rust algae" is usually used. The disease occurs on branches 1-2 years old. Leaves above the diseased areas turn yellow, white, and variegated and usually develop circular zones with purple margins. Orange- or brick-colored hairlike fructifications may form on damaged tissue under humid conditions. The main control is to improve host plant vigor by correcting cultural malpractices, ie, improve soil fertility and eliminate shading by weed control.

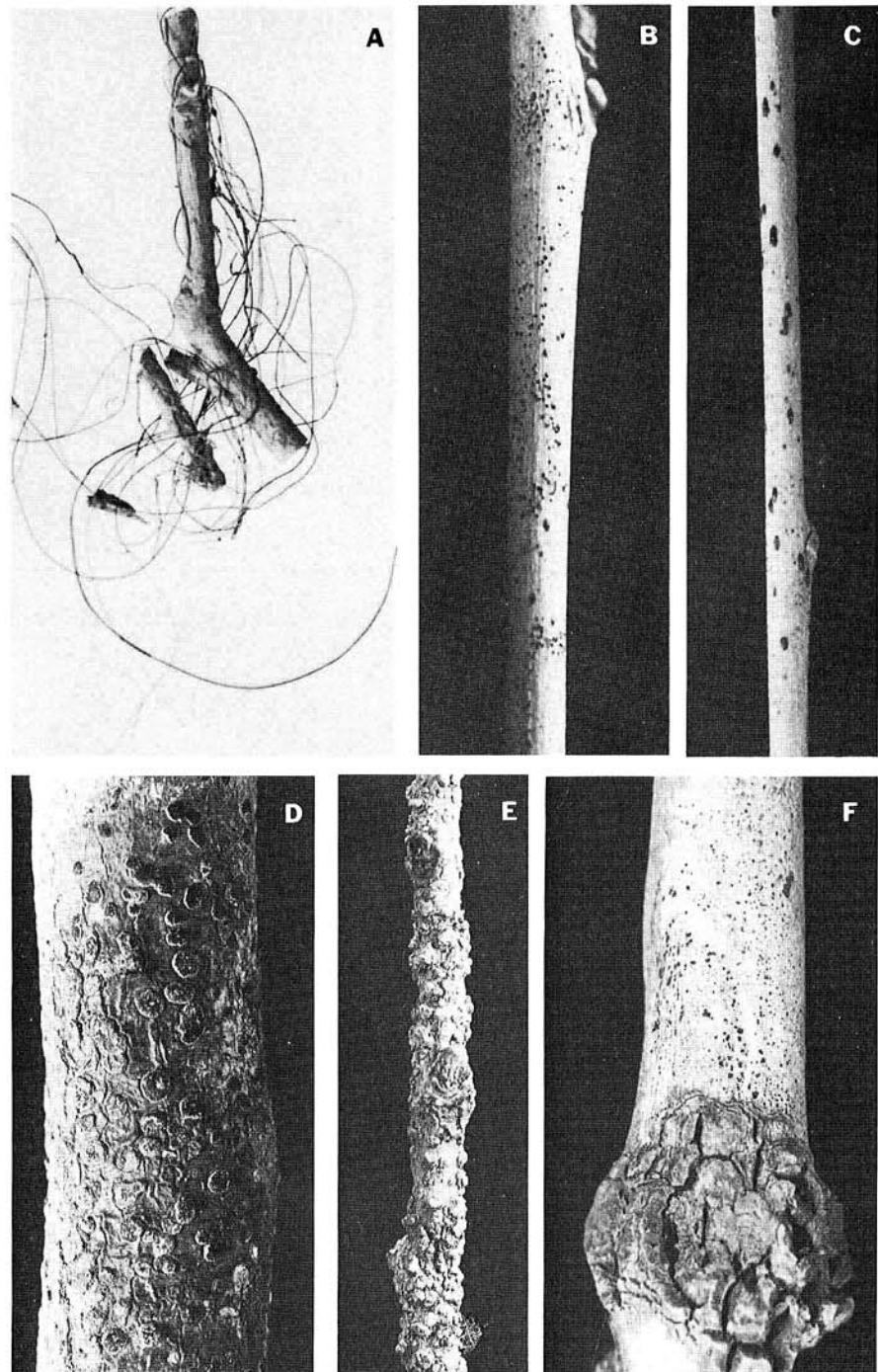


Fig. 2. Tea stem diseases occurring in the People's Republic of China include: (A) hair disease caused by *Marasmius* spp., (B) twig blight caused by *Phomopsis* sp., (C) twig blight caused by *Cenangium* sp., (D) stem blight caused by *Patellaria theae*, (E) stem tumor caused by *Nectria* sp., and (F) stem canker caused by *Phomopsis* sp.

Cephaleuros virescens Kunze is weakly parasitic on the subcuticle and upperside of mature tea leaves but causes no serious damage. Joubest and Rijkenberg (5) suggest that *C. virescens* and *C.*

parasiticus may be two forms of the same species. More work is needed to clarify the taxonomic position of these two algae.

Several other stem diseases occur in

China but are not generally serious. **Hair disease** (Fig. 2A) caused by *Marasmius* spp. occurs frequently in China. *Phomopsis* sp. and *Cenangium* sp. both cause **twig blight** (Figs. 2B and 2C); infected shoots produce slender buds. *Patellaria theae* Hara (Fig. 2D), *Hysteriopsis theae* Hara, *Nectria* sp. (Fig. 2E), and *Phomopsis* sp. (Fig. 2F) attack the bark of the tea bush and are mostly of mycological interest.

Root Diseases

Tea root diseases have aroused much attention in China in recent years and have tended to become more serious with the practice of fertilization (2). The most important are **root knot** (Fig. 3A) caused by *Meloidogyne incognita* Chitwood and *M. javanica* Chitwood, **red root rot** caused by *Poria hypolaterite* Berk., **brown root rot** caused by *Phellinus maxius* Corner, and **charcoal stump rot** caused by *Ustulina zonata* (Lév.) Sacc. *Pratylenchus* sp. causes brown lesions on the main roots, plant stunting, and sometimes a witches' broom symptom (1). Root knot is most serious on tea seedlings 1-3 years old. Best control has been obtained with DBCP (80% E.) applied at 2.5-5 ml/m² (9).

Red root rot, brown root rot, and charcoal stump rot are important mainly in the southern provinces, especially where forests have been cleared to plant tea. The pathogens have occurred in forest root debris, which becomes the source of inoculum and the food base for attack of the tea plants. The main control

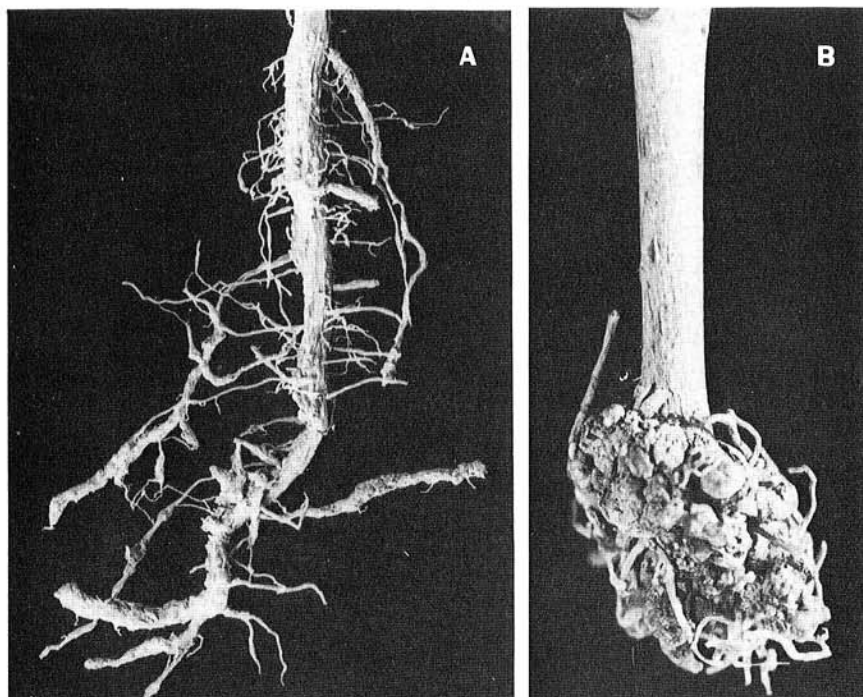


Fig. 3. Examples of tea root diseases occurring in the People's Republic of China are (A) root knot caused by *Meloidogyne incognita* and *M. javanica* and (B) crown gall caused by *Agrobacterium tumefaciens*.



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Table 4. Mosses and lichens present as epiphytes on tea plants

Mosses

Acrocryphaea concavifolia Griff.
Arthotrichum sp.
Barbella asperifolia Card.
B. pendula (Sull.) Fleisd.
B. stewensis (Rem. et Card.) Fleisch
Drummondia sinensis Mill.
Entodon attenuatum Mill.
Forsstroemia sinensis (Besch.) Par.
Frullanis schensiana Mass.
Hypnum revolutum (Mitt.) Lindb.
Macromitrium incurvum
(Lindb.) Paris
Meteoriopsis reclinata (Mitt.) Fleisch
Meteorium helmintocladulum
(Card.) Broth
Metzgeria sinensis Chen.
Plagiochila okamurania St.
Pseudoleskeella catenulata
(Brid.) Kindli.
Schwetschkeia sinica Broth et Paris
Thuidium assimile (Mitt.) Gaeg.

Lichens

Alectoria sp.
Parmelia sp.
P. cetrata Ach.
Physcia stellaris Nyl.
P. caesia (Hoffm.) Hampe.

procedures are to remove and burn the forest tree stumps and to allow the land to dry thoroughly before planting. Where stump removal is not possible within a garden, trenches are dug to isolate the stump from surrounding tea plants. Even, apparently healthy tea bushes must be removed if located near a diseased bush. Infested areas may be treated with pentachloronitrobenzene (PCNB). Some control can be obtained by treatment with either dodemorph or tridemorph, although the latter may produce phototoxicity to tea plants.

Violet root rot caused by *Sphaerostilbe repens* Berk. & Br., **Fomes root rot** caused by *Fomes lignosus* Kletzsch, and **Diplodia disease** caused by *Botryodiplodia theobromae* Pat. occur in China as secondary diseases related to improper environment provided by tea cultivation. These diseases can be controlled by improving the growing conditions for tea.

Damping-off caused by *Hypochnus centrifugus* (Lév.) Tul. can be important in tea nurseries in southeastern China. The fungus destroys the basal part of the seedling stem, diseased parts become covered with mycelia and sclerotia, and the seedlings wilt and die. Damage can be most serious during a dry season. Best control is obtained by using virgin soil in the nursery. Some control can be obtained by applying PCNB, 10–20 kg a.i./ha, as a dust around the seedlings during the early stage of infection. **Crown gall** (Fig. 3B) caused by *Agrobacterium tumefaciens* Smith is important on tea cuttings in China.

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