

The identity of *Oidium caricae* and the first recording on papaya, mountain papaya and babaco in New Zealand

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DETERMINATION D'OIDIUM CARICAE SIGNALE POUR
LA PREMIERE FOIS SUR PAPAYER, PAPAYER DE MONTAGNE
ET BABACO EN NOUVELLE ZELANDE

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RESUME - L'*Oidium caricae* est signalé pour la première fois sur le papayer (*Carica papaya*), le papayer de montagne (*Carica pubescens*) et le papayer babaco (*C. pubescens* x *C. stipulata*) en Nouvelle Zélande. Cet oïdium a été identifié comme la forme imparfaite de *Erysiphe cruciferarum*. Il a été transmis facilement du rutabaga à la papaye et de la papaye au radis sauvage. *Erysiphe cichoracearum* a été trouvé sur le papayer et le papayer de montagne.

Un résumé est donné des 12 oïdiums qui ont été décrits sur papaye, ainsi que les aires de distribution géographique.

INTRODUCTION

The papaya, a valuable food and drug plant in many tropical and subtropical countries, is host to an unusually large number of powdery mildews. Although there are reports of twelve powdery mildews from all over the world, the actual distribution of the different species is unknown as several powdery mildews have been confused. For several countries it is still unknown which species occur.

The oldest known species is *Oidium caricae* NOACK, first reported in 1898 from Brazil and now thought to occur all over the world (FROSSARD, 1969; HIRATA, 1966). However, although this species has been reported from many countries e.g. the Philippines (REINKING, 1919), the only reliable identifications are from Brazil, India, Kenya

(YEN, 1966) and Madagascar (SECHET, 1953). During the present study *O. caricae* was found also in New Zealand and Taiwan. In the type description NOACK (1898) gave as conidial size 23-25 x 14.5-20 μ m but after examination of type material, YEN (1966) found the conidia to be long cylindrical and measuring about 38-51 x 16-20 μ m.

A second species, *O. indicum* CHIDDARWAR which was described from India (CHIDDARWAR, 1955), is morphologically identical with *O. caricae* (YEN, 1966). In both species the conidia are produced singly and they lack conspicuous fibrosin bodies.

A third species occurs in Indonesia and Australia. It was first erroneously reported as *O. caricae* from Java by VAN OVEREEM and SCHWARZ (1926). Their detailed study, excellent illustrations of ovoid conidia which are produced in long chains and contain conspicuous fibrosin bodies and their observation that the conidiophores are only occasionally delimited from the mycelium by a septum, indicate that their species are *Sphaerotheca alchemillae* (GREV.)

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JUNELL. In 1928 the perfect state of *S. alchemillae* was found on papaya in Australia (CLARE, 1964).

Sphaerotheca fuliginea (SCHLECHT. ex FR.) POLL. was first reported from California because MILLER (1938) observed that from 1935 onwards the common cucurbit mildew occurred on papaya. Later on the conidial state was found in Australia (ALCORN, 1968) and the cleistothecia were found in India (MUNJAL and KAPOOR, 1973). During the present study it was identified from herbarium samples from China.

Oidium caricae-papayae YEN was newly described from Taiwan (YEN, 1966). It produces lobed appressoria and conidia in long chains but lacks conspicuous fibrosin bodies.

Erysiphe cichoracearum DC. ex MERAT was reported from Peru (DONGO and ROCHA, 1968). During the present study it was found on papaya and mountain papaya in New Zealand. It produces unlobed appressoria and long chains of conidia but lacks conspicuous fibrosin bodies.

Oidium caricicola YEN and WANG was described from Taiwan with characteristics which are similar to those of *E. cichoracearum* (YEN and WANG, 1973).

The conidial state of *Phyllactinia guttata* (WALLR. ex FR.) LEV. has been reported from numerous countries and under several names including *Ovulariopsis caricae* SAW. (SAWADA, 1933) and *Ovul. papayae* VAN DER BIJL (VAN DER BIJL, 1921). A similar species, but producing a perfect state, was described by VIEGAS (1944) from Brazil as *Ph. caricaefolia* VIEGAS. *Leveillula taurica* (LEV.) ARN. with the conidial state *Oidiopsis taurica* (LEV.) SALM. occurs on papaya in Australia (CLARE, 1964), India (ULLASA and SOHI, 1978), Japan (HOMMA, 1937) Malawi (PEREGRINE, 1972) and Nyasaland (HIRATA, 1966).

MATERIALS, METHODS AND RESULTS

No powdery mildew has been reported from New Zealand where only the mountain papaya is commonly grown. To discover the identity of *O. caricae*, 100 seedlings of *Carica papaya* (papaya), 20 of *Carica pubescens* (mountain papaya) and two cuttings of *C. pubescens* x *C. stipulata* (babaco) were raised during 1981 in two glasshouses for the purpose of inoculation experiments with powdery mildews from other plants. A few seedlings of papaya became naturally infected with *E. cichoracearum* but the disease did not spread to most of the plants.

Study of the literature and of herbarium material showed that in different countries different mildews occur on papaya (Fig. 1 ; Table 1). A sample from Yunnan, China, showed the presence of *S. fuliginea*. Whereas a sample from Taipei, Taiwan, was infected with a different mildew which was identical with samples from Brazil. The type of *O. caricae*, collected November 1897 in Campinas and a later sample, collected July 1944 in Piracicaba, Brazil, revealed

that the mycelial appressoria are multilobed and the conidia long cylindrical, 40-51 x 10-16 μm and produced singly.

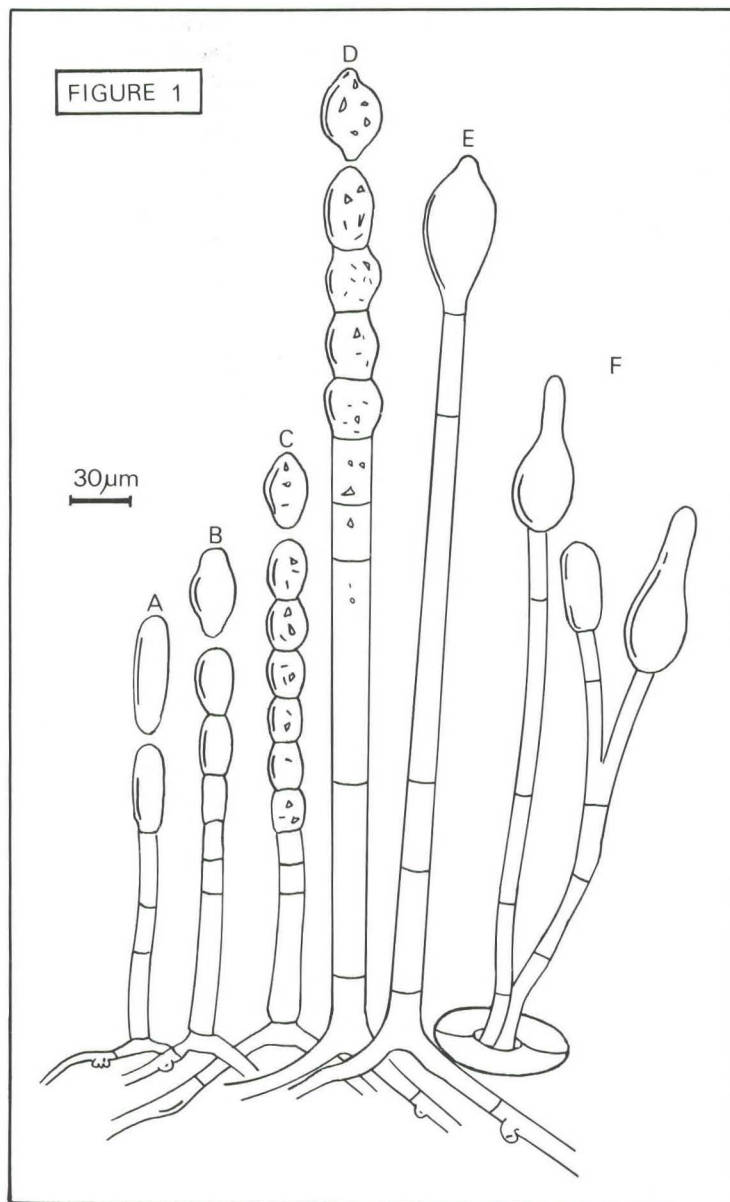
TABLE 1 - Distribution of powdery mildews on papaya.

<i>Oidium caricae</i> - <i>Erysiphe cruciferarum</i>	Brazil, India, Kenya, Madagascar, New Zealand, Taiwan.
<i>Oidium indicum</i>	India.
<i>Oidium caricicola</i>	Taiwan
<i>Oidium caricae-papayae</i>	Taiwan.
<i>Erysiphe cichoracearum</i>	Peru, New Zealand.
<i>Sphaerotheca alchemillae</i>	Indonesia, Australia.
<i>Sphaerotheca fuliginea</i>	California, India, Australia, China.
<i>Leveillula taurica</i>	Australia, India, Japan, Malawi, Nyasaland.
<i>Phyllactinia guttata</i>	Ivory Coast, India, Kenya, Madagascar, Mauritius, Mozambique, Nyasaland, Natal, Reunion, Rhodesia, Ruanda, Sierra Leone, South Africa, Sudan, Taiwan, Tanganyika, Venezuela.
<i>Phyllactinia caricaefolia</i>	Brazil
Unidentified species	Bermuda, Cuba, Egypt, El Salvador, East Africa, Florida, Guatemala, Hawaii, Honduras, Jamaica, Madagascar, Mexico, New Caledonia, New Guinea, Panama, Philippines, Portugal, Rumania, San Salvador, Sierra Leone, Rhodesia, Tanganyika, Uganda, Venezuela, Pakistan.

These characteristics are typical of those of *E. cruciferarum* OPIZ ex JUNELL, a species which in New Zealand occurs commonly on *Raphanus raphanistrum* (wild radish). This species was therefore used to inoculate papaya.

For inoculation experiments, *E. cruciferarum* was first transferred from wild radish to *Brassica napus* var. *napobrassica* (swede) and on the swede it was maintained in the glasshouse for more than a year. Potted seedlings of papaya and mountain papaya were placed near the infected swede and after two months they became naturally infected with powdery mildew. In the other glasshouse, seedlings of papaya and mountain papaya were raised in isolation. After about six months, when they were still uninfected, conidia of *E. cruciferarum* from swede were dusted on marked leaves after which the plants were enclosed in a plastic bag. Within seven days infection was visible but on inoculated leaves only.

When healthy plants of wild radish were inoculated with the mildew from papaya, both young and old leaves beca-



A = *Oïdium caricae*, B = *Erysiphe cichoracearum*, C = *Sphaeroteca fuliginea*, D = *Sphaeroteca alchemillae*, E = *Phyllactinia guttata*, F = *Leveillula taurica*.

me readily infected after seven days. Control plants remained healthy.

The two babaco plants were also easily infected with the mildew from swede. During December 1981 natural infection of babaco was observed in a small nursery in Auckland.

Symptoms.

On babaco moderately severe leafspots occurred but no stem infection was observed.

On papaya, severe infection of *E. cruciferarum* occurred on naturally infected and on inoculated plants. The stem and petioles became entirely surrounded by a white fungal growth and the leaves showed large white blotches. Both sides of the leaves were attacked, especially near the veins, and the spots were up to 2 cm wide.

On mountain papaya infection with *E. cruciferarum* was slight and occurred on the leaves only. Extensive examination of mature trees in gardens in Auckland failed to reveal natural infection with *E. cruciferarum*, but one tree was found to be infected with *E. cichoracearum*. Numerous

spots occurred on both sides of the leaves, but the disease appears to be otherwise harmless.

DISCUSSION

From examination of type material and from inoculation experiments, it is concluded that *O. caricae* from South America is the imperfect state of the well known crucifer mildew, *E. cruciferarum*. In South America this cosmopolitan species occurs on at least eight different species of *Brassica* (VIEGAS, 1961), and from the present study it is concluded that the genus *Carica* is also included in its host range.

Several species of powdery mildew including *E. cichoracearum*, *L. taurica*, *Ph. guttata* and *S. fuliginea* have a wide host range. For example *S. fuliginea*, which HIRATA (1966) listed on numerous host plants, could be successfully transferred by ALCORN (1968) from cucumber to papaya and to seven other hosts outside the Cucurbitaceae. BOESEWINKEL (1979) showed that the host range of several species is wider than is commonly believed and it appears that *E. cruciferarum* is one of the polyphagous species.

Whereas *S. alchemillae* is very damaging to papaya and can even kill the young growing tip and attacks the fruit (SIMMONDS, 1965), *E. cruciferarum* appears to be less ca and *S. alchemillae* and Dr. PARADELA FILHO, Instituto

not very harmful on papaya in Brazil. The present study indicates that different host plants differ in their susceptibility. The disease was severe on glasshouse grown papaya, a plant which is rarely grown in New Zealand because of the relatively cool climate. The disease was harmless on mountain papaya, a plant which originates from the mountains of Colombia and Ecuador. Mountain papaya is a common garden plant in New Zealand but so far natural infection with *E. cruciferarum* has only been found on glasshouse grown plants. Of more interest to New Zealand is the susceptibility to *E. cruciferarum* of young and older babaco plants, a rare plant from the valleys of the inter-Andean region of Ecuador; the babaco is at present being developed as a commercial crop in New Zealand.

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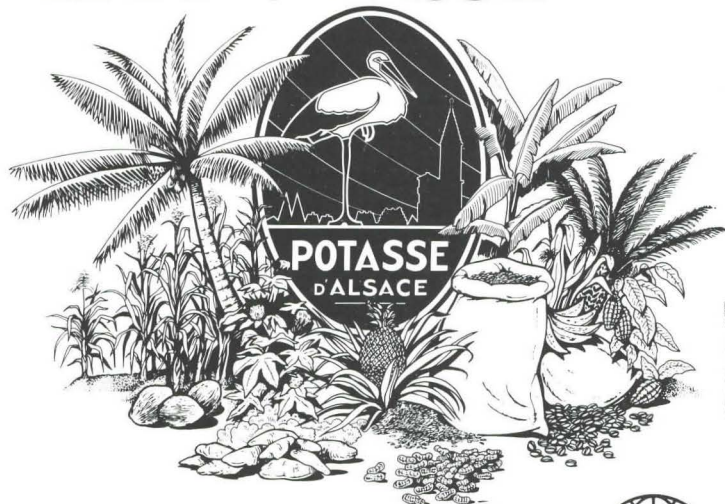
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