

Life-history Studies of New Zealand Species of *Nectria* Fr.

By JOAN M. DINGLEY

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Abstract

LIFE histories of twenty-six New Zealand species of *Nectria* have been studied. They show that conidial forms bear some relationship to the diverse perithecial structures found within the genus. Conidial forms are shown to belong to the form genera *Cylindrocarpon* Wollenw., *Dendrodochium* Bon., *Fusarium* Link ex Fr., *Tubercularia* Tode ex Fr. and *Verticillium* Nees ex. Wallr.

SPECIES of *Nectria* recorded in New Zealand by Dingley (1950) have been investigated with the object of ascertaining the value of asexual spore forms in classification. In all species examined in which asexual spores have been observed, conidia develop in basipetal succession from the apices of phialides, arising as terminal branches of conidiophores which are produced as lateral branches of a superficial mycelium. Conidiophores may be formed in large numbers from superficial rope-like mycelium which unite to form pionnotes, sporodochia or synnemata; and the pseudoparenchymatous bases of stromata are also formed from these mycelial ropes. Perithecial initials develop superficially on a stroma among spent conidiophores, outer walls of the perithecia being continuous with the stromal tissue. Microconidia are sometimes present and chlamydospores develop in some species.

METHOD

Single spores from fresh perithecia were germinated on petri dishes containing "Difco" prune agar, then re-isolated to potato dextrose agar and incubated for three weeks at 25° C. Cultures were kept for a further three weeks in light at room temperature, examined and conidia measured. Conidial forms obtained in these cultures were compared with those found among perithecia in field collections. In some cultures perithecia were formed.

LIFE HISTORIES

Life histories are discussed under sections classified according to the structure of perithecia, namely:

(I) Species with hyaline perithecial walls, pigment present in globules in and among the cells; sub-hymenial layer diffluent.

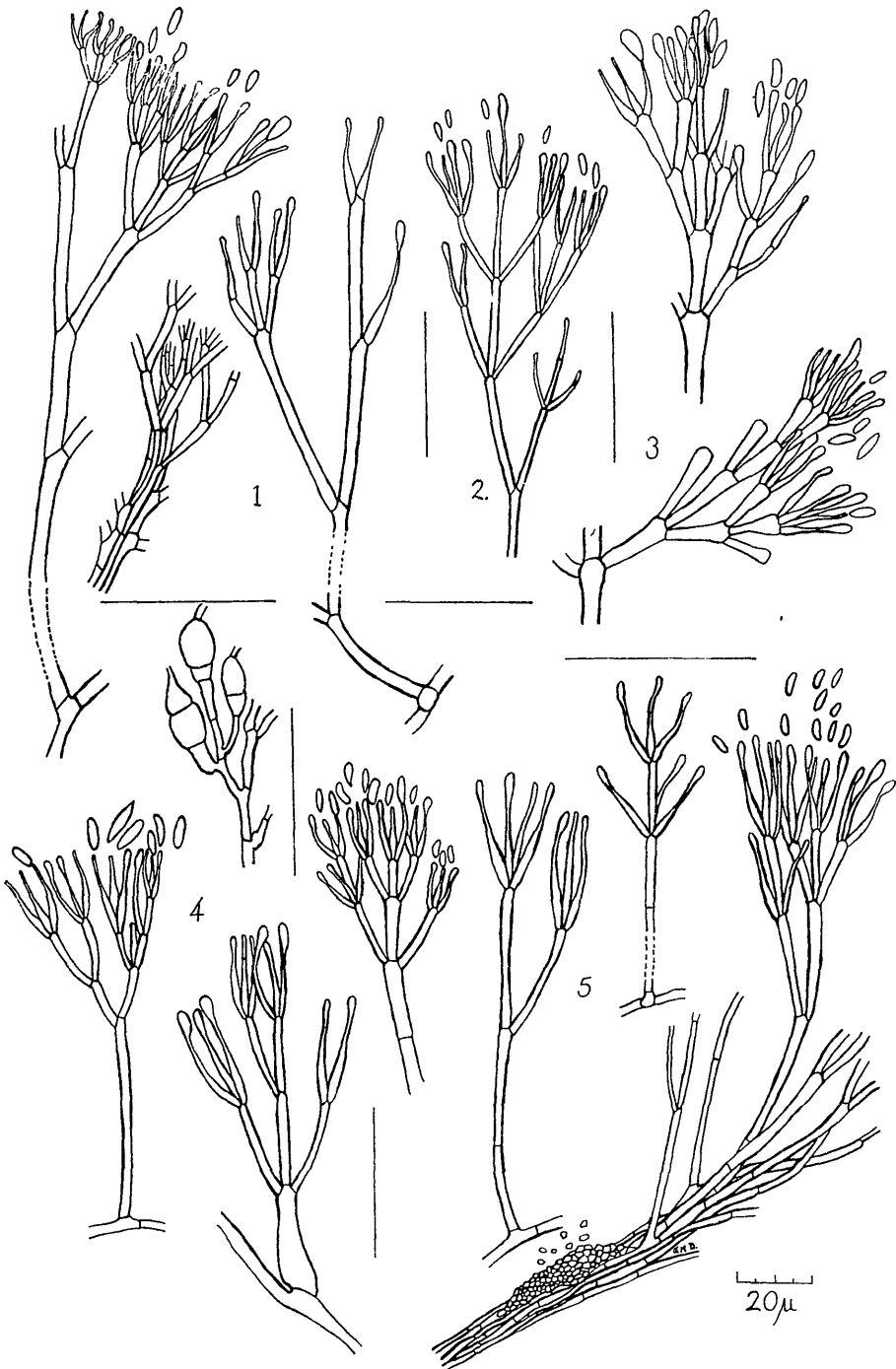
(II) Species with hyaline or lightly pigmented perithecial walls, subhymenial layer sometimes thickened and pigmented.

(III) Species with pigmented and thickened perithecial walls

I. SPECIES WITH HYALINE PERITHECIAL WALLS, PIGMENT PRESENT IN GLOBULES AMONG CELLS

Included in this group are *N. aureo-fulva* Cke & Ellis, *N. egmontensis* Dingley, *N. kowhai* Dingley, *N. ochroleuca* (Schw.) Berk. and *N. stenospora* Berk. & Br.

In field collections, in all species, conidia are catenulated from more or less pulvinate, pale coloured erumpent sporodochia. In longitudinal and tangential sections sporodochia appear to be zoned because of the regular dichotomous branching of conidiophores. Occasional floccose clusters of conidiophores are found especially in immature collections. Conidia are unicellular, elliptical, oval or allantoid, 4-15 x 1.5-4 μ . The mycelium in cultures is floccose, white, occasionally pale salmon



TEXT-FIG. 1.—FIG. 1.—Conidial forms of *N. aureo-fulva*. FIG. 2.—Conidial forms of *N. ochroleuca*. FIG. 3.—Conidial forms of *N. egmontensis*. FIG. 4.—Conidial forms of *N. kowhai*. FIG. 5.—Conidial forms of *N. stenospora*.

or ochraceous, especially when grown in light. In young cultures conidiophores are produced singly from lateral hyphae and may be either verticillately or penicillately branched, terminal branches ending in flask-shaped phialides from which conidia are catenulated. Aerial ropelike mycelium are formed in distinct zones in immature cultures; from them arise clusters of conidiophores which become fused to form sporodochia. These intergrading forms vary from single conidiophores to sporodochia 1–2 mm in diameter. They are found both in field collections and in pure cultures, and have been classified under the form genera *Acrostalagmus*, *Dendrodochium*, *Gliocladium* Corda, *Isaria* Pers. ex Fr., *Spicaria* Auct., *Tubercularia* and *Verticillium*.

Nectria aureo-fulva Cke. & Ellis

Erumpent, pallid sporodochia are formed exhibiting zonation in tangential and longitudinal sections typical of *Dendrodochium*. In young cultures conidiophores are produced singly; they measure 50–150 x 3 μ , are septate, possess rough walls, and are verticillately branched; in older cultures, in more or less distinct zones, conidiophores are borne on aerial rope-like mycelium and united to form sporodochia. Terminal phialides measure 10–25 x 2.5–3.5 μ . Conidia are unicellular, hyaline, oval or elliptical, often allantoid, 4.5–7.5 x 2.5–3.5 μ (Text-fig. 1, 1).

Perithecia were formed in cultures four to six weeks old.

Nectria egmontensis Dingley

Erumpent more or less effused sporodochia are formed in longitudinal crevices in host tissues. Cultures are slower growing than those of *N. aureo-fulva*. Conidiophores are sparse, measure 80–150 x 3 μ , verticillately sometimes penicillately branched, septate and usually swollen below septa. Terminal phialides measure 10–20 x 2–2.5 μ . Conidia are unicellular, elliptical, oval or allantoid, hyaline, 6–10 x 3–4.5 μ (Text-fig. 1, 3).

Nectria kowhai Dingley

Pale salmon-coloured erumpent sporodochia are formed on the host, and are often floccose when young. Conidiophores are verticillately branched, often produced on ropelike mycelium in distinct zones in the culture. Conidia are unicellular, elliptical, fusiform, 8–15 x 2.5–3.5 μ . Clusters of pyriform chlamydospores are often present among the mycelium (Text-fig. 1, 4).

Nectria ochroleuca (Schw.) Berk.

More or less floccose pale pink sporodochia are formed superficially on the host. In young cultures mycelium is slow growing and pale salmon in colour. Conidiophores are formed singly or in clusters when they unite to form drab-coloured, slimy sporodochia. Terminal phialides measure 7–15 x 1.5–2 μ . Conidia are unicellular, elliptical, oval, 3–4.5 x 1.5–2 μ (Text-fig. 1, 2).

Nectria stenospora Berk. & Br.

Sporodochia are effuse, sometimes erumpent, pale salmon, sometimes ochraceous, and formed superficially on the surface of the host. In cultures the floccose mycelium becomes salmon pink when grown in light. Conidiophores are at first sparse, become verticillately branched, and later grow in clusters, especially on rope-like mycelium. Phialides are 10–15 x 1.5–2 μ . Conidia are 4.5–7 x 2–3 μ . Microconidia are present in large numbers as arthrospores, often among the "mycelial ropes" (Text-fig. 1, 5).

Perithecia are formed in cultures four to six weeks old.

II. SPECIES WITH HYALINE OR LIGHTLY PIGMENTED PERITHECIAL WALLS; SUBHYMENIAL LAYER OFTEN THICKENED AND PIGMENTED

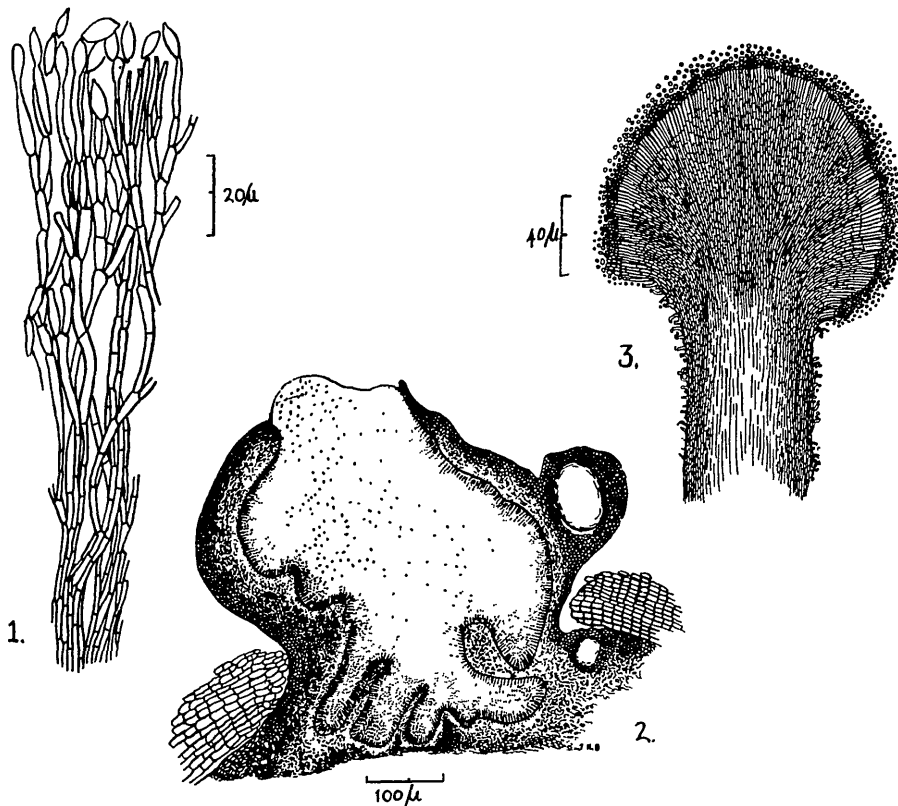
Only five New Zealand species have been studied. As no characteristic conidial form has been found to be common to all species in this section, each species is discussed separately.

Nectria peziza (Tode) Fr.

No conidial form was found among perithecia in field collections. Single spore cultures produced only intercalary chlamydospores which, formed in chains of four to six, were globular, thick walled, 5–8 μ diameter. Perithecia develop in cultures six weeks old.

Nectria cyathea Dingley

No conidial form was found among perithecia in field collections. Cultures are slow growing, isabelline, floccose, sometimes zoned. Arthrospores are formed among ropelike



TEXT-FIG. 2.—FIG. 1.—Conidial forms of *N. ralfsii*. FIG. 2.—Conidial forms of *N. otagensis*. FIG. 3.—Conidial forms of *N. macrostoma*.

mycelium. Intercalary chlamydospores were also present, more or less globose, 8–15 μ in diameter. Perithecia form in cultures 6–8 weeks old

Nectria ralfsii Berk. & Br.

Erumpent sporodochia covered with dark translucent masses of conidia occur among clusters of immature perithecia. From single ascospore isolations developed a white floccose culture. White pulvinate sporodochia were formed which, when mature, became translucent, greenish-black with catenulated conidia. Conidiophores form a superficial layer up to 200 μ long; they are penicillately branched, terminating in phialides 15–20 \times 2–3 μ . Conidia are broadly elliptical, 10–18 \times 7–9 μ , often with a distinct papilla and pigmented, thickened walls. Intercalary chlamydospores were present among mycelium of the sporodochia (Text-fig. 2, 1). Rilestone (1941) noted "that Mr. E. W. Mason regarded this conidial form as identical with *Sphaeropsis henriquesii* Thumen, but that as the conidia are not borne in pycnidia the fungus cannot be classified as a *Sphaeropsis*; for the present it should be known as the conidial form of *N. ralfsii*." Sections of young sporodochia show a structure similar to the superficial layer of *Dendrodochium*. Conidiophores are branched penicillately, and often swollen below septa, while branches terminate in phialides from which pigmented, not hyaline, conidia are catenulated.

Nectria macrostoma Berk. & Curt

In field collections clusters of perithecia are aggregated around bases of the synnemata, stalks of the synnemata are dark coloured, whereas conidial heads are pale salmon and translucent; sporodochia are present. In cultures synnemata 0.5 mm long are formed in small clusters of 2–5 arising from small byssoid stromata. When immature the dark stalks terminate in penicillately branched hyaline conidiophores, each branch ending in a typical subulate phialide. In mature fructifications, terminal branches become compacted together and slimy conidia, catenulated from phialides, adhere together to form globose, pale salmon translucent heads.

Conidia are hyaline, globose or broadly elliptical, $2-6 \times 1.5-3.5\mu$. Intercalary chlamydo-spores are present in the mycelium (Text-fig. 2, 3). This conidial stage conforms with the imperfect form-genus *Graphium* Corda, as defined in its limited sense by Mason (1937).

Nectria otagensis Currey ex Lindsay

On some young stromata immature perithecia surround large cavities filled with orange translucent conidial masses. Superficially these cavities appear as labyrinthiform pycnidia, but neither a true ostiole nor a distinct wall is present; hyphae from the stroma converge around them, and from this layer of tissue arise regularly arranged phialides to form a compact layer lining each cavity. Conidia are catenulated, adherent, fill the central cavity, and exude as an orange, waxy mass. Conidia are unicellular, elliptical, sometimes more or less bacilliform, hyaline, $2-5 \times 1.5-2\mu$ (Text-fig. 2, 2). This conidial stage is typical of the form genus *Aschersonia* Mont., usually associated with *Hypocrella* Sacc., a genus in the Clavicipitaceae. In cultures conidia are catenulated from phialides which form lateral branches on aerial hyphae; sometimes hyphae are compacted into a slimy stroma. Conidia are unicellular, allantoid, $3-4 \times 0.75-1.5\mu$.

III. SPECIES WITH PIGMENTED AND THICKENED PERITHECIAL WALLS

In this section conidia are catenulated from phialides united on sporodochia or pionnotes, or from short lateral branches of aerial, pigmented hyphae. Conidiophores are rarely produced singly, but if so, then they are more or less verticillately branched. When united on pionnotes or sporodochia, conidiophores are obscurely differentiated from the pseudoparenchymatous stroma. Conidia are either unicellular, or bear one or more transverse septa. Life histories of species are described under the following subsections:

1. Species with conidia typical of the form genus *Tubercularia*.
2. Species with conidia typical of the form genus *Cylindrocarpon*.
3. Species with conidia typical of the form genus *Fusarium*.

1. Species with Conidia Typical of the Form Genus *Tubercularia*

Unicellular conidia are catenulated from phialides arising as terminal branches of short conidiophores arranged superficially on pseudoparenchymatous sporodochia. *N. cinnabarina* (Tode) Fr. is the only species present in New Zealand.

Nectria cinnabarina (Tode) Fr.

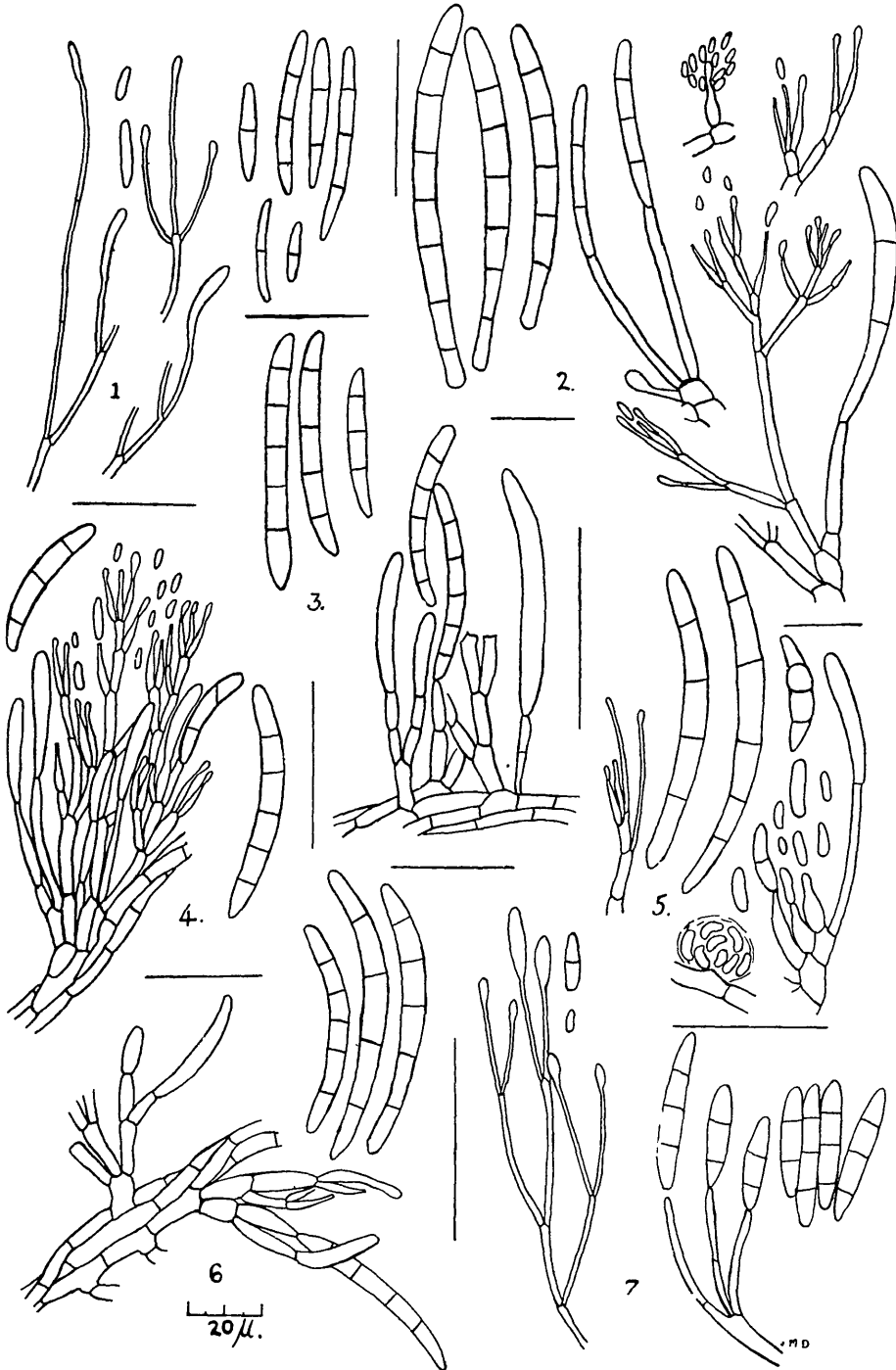
Sporodochia are erumpent, to 3 mm diameter, orange sometimes amber, translucent, pseudoparenchymatous with cells $5-10\mu$ diameter, pigmented and thickened. Conidiophores are $50-100\mu$ long, compacted together. Conidia are one-celled, oblong or oval, sometimes cylindrical or allantoid, $6.8 \times 2-2.5\mu$, hyaline. Cultures have not been studied. The conidial stage is named *Tubercularia vulgaris* Tode ex Fr.

2. Species with Conidia Belonging to the Form Genus *Cylindrocarpon*

Under this subsection are treated *N. coprosma* Dingley, *N. fragilis* Dingley, *N. galligena* Bres. ex Strasser, *N. pinea* Dingley, *N. punicea* (K. & Schm.) Fr., *N. tasmanica* Berk., *N. tawa* Dingley and *N. westlandica* Dingley.

The imperfect form-genera *Cylindrocarpon* and *Fusarium* are separated from *Tubercularia* because conidia are provided with one or more transverse septa, although unicellular spores are also present. Wollenweber (1913) erected *Cylindrocarpon* to contain species with cylindrical, multiseptate conidia, but without chlamydo-spores. He emended *Ramularia* (Unger) Fr. to embrace species with cylindrical multiseptate conidia but with chlamydo-spores.

Later (in 1926) and (in 1928) he placed species with chlamydo-spores in *Cylindrocarpon* and appears to have limited *Ramularia* to species in which conidia were developed in acropetal chains. Consequently, Hughes (1949) held *Ramularia* to be limited to species in which conidia are developed in acropetal chains of dry terminal thallospores and included in *Cylindrocarpon* the species with slimy conidia produced in basipetal succession from ends of phialides. *Cylindrocarpon* is separated from *Fusarium* by the shape of the macroconidia. In the latter they are falcate with



TEXT-FIG. 3.—FIG. 1.—Conidial forms of *N. coprosma*. FIG. 2.—Conidial forms of *N. fragilis*. FIG. 3.—Conidial forms of *N. pinea*. FIG. 4.—Conidial forms of *N. westlandica*. FIG. 5.—Conidial forms of *N. punicea*. FIG. 6.—Conidial forms of *N. tasmanica*. FIG. 7.—Conidial forms of *N. tawa*.

a distinct apiculate terminal cell and a basal foot cell; in the former cylindrical with rounded apex and without a foot cell.

Nectria coprosma Dingley

Field collections yielded no conidial forms. Cultures are bay coloured and floccose. Sparsely branched conidiophores form small translucent pionnotes 0.5–1 mm diameter. Conidia are catenulated from terminal phialides, cylindrical, 1–3 septate, rarely 0–2–4 septate (1 septate 14–30 x 3.5–4.5 μ , 3 septate 28–47 x 4.5–5 μ). Unicellular microconidia are also present, 3–7 x 1.5–3 μ . Chlamydo-spores are absent (Text-fig. 3, 1). Perithecia developed in cultures two months old.

Nectria fragilis Dingley

Conidia are formed on poorly developed translucent sporodochia formed in longitudinal crevices in bark of the host. In cultures, mycelium is floccose, chestnut brown, sometimes ochraceous. Conidia are formed on translucent pulvinate sporodochia, 1–2 mm diameter. Conidiophores are more or less dichotomously branched and conidia are catenulated from terminal phialides. They are cylindrical, slightly swollen at the base, rounded at the apex, 0–7 septate, mostly 5–7 septate, then 68–81 x 5–6 μ . In young cultures two to three weeks old, conidia are 2–3 septate, then 37–56 x 4.5–5 μ . Microconidia 7.5–10 x 2–3 μ in size, commonly bud off from macroconidia. Intercalary chlamydo-spores, 7–10 μ diameter, are common (Text-fig. 3, 2).

Nectria galligena Bres. ex Strasser

Conidia are aggregated in small white pustules or pionnotes, not more than 0.5 mm diameter, and formed among the diseased tissue of the canker on the host. Cultures are bay brown, floccose. Pionnotes are poorly defined since conidiophores are sparsely branched, and are scattered in small clusters. Conidia are catenulated from terminal phialides, cylindrical, linear, sometimes curved, 1–3–4–5 septate, mostly 3–4 with apex rounded (3 septate 19–33 x 3–4 μ ; 4 septate 27–42 x 3–4.5 μ). Chlamydo-spores are absent. *C. mali* (Allsch.) Wollenw. is the name of this conidial stage.

Nectria pinea Dingley

In field collections pale erumpent pulvinate pionnotes are found among the perithecia. Cultures are bay brown, sometimes pale ochraceous and floccose. Pionnotes are numerous, small, formed in zones, usually on "mycelial ropes", translucent, more or less hyaline. Conidiophores are short and sparsely branched. Conidia are cylindrical, 3–4–5–6 septate, usually 4–5–6 (4 septate 59–67 x 5–6 μ ; 5 septate 60–81 x 5–7 μ , 6 septate 60–76 x 6–7 μ). Microconidia and chlamydo-spores are absent (Text-fig. 3, 3).

Conidial measurements of New Zealand cultures agree with Wollenweber's description (1928) of *C. cylindroides* rather than *C. cylindroides* var. *tenuis* Wollenw. the form which he described as the conidial stage of this species. Perithecia of New Zealand material match European collections.

Nectria punicea (Kunze & Schmidt) Fr.

Erumpent sporodochia, translucent, white, but pigmented when forming perithecia, are present on the host. In cultures mycelium is floccose and cinnamon brown. Sporodochia are pulvinate, hyaline and translucent. Conidiophores are difficult to differentiate from the pseudo-parenchymatous tissues of the stroma. Conidia are catenulated from terminal phialides, 0–7 septate, usually 0–3–7 septate (3 septate 27–51 x 3.5–4.5 μ ; 7 septate 68–88 x 4.5–5.5 μ). Microconidia are common, catenulated from apices of elongated conidiophores, elliptical or fusiform, 10–14 x 4–5 μ . Chlamydo-spores are globose and 10–15 μ diameter (Text-fig. 3, 5).

Isolations from different collections yielded cultures that vary from forms typical of *C. album* (Sacc.) Wollenw. and of *C. album* var. *majus* Wollenw. Similar variation was not found in the morphology of the perithecia

Nectria tasmanica Berk.

Translucent, pulvinate sporodochia, erumpent, hyaline when moist, but darkening to vinaceous brown when dry and when forming perithecia, occur on tissues of the host plant. Cultures are vinaceous brown, sometimes violet, often floccose with brown aerial hyphae. Sporodochia are cream, translucent, darkening when forming perithecia. Conidiophores are short, verticillately and penicillately branched. Conidia are cylindrical, falcate, rarely one-septate, usually 3–4–5 septate, sometimes 6 (3 septate 42–60 x 4–4.5 μ ; 4 septate 50–65 x 5–6 μ). In cultures stored for six months at 3–5°C. conidia are 5–7 septate and 70–120 x 7–8 μ . Microconidia are rare and chlamydo-spores are absent (Text-fig. 3, 6). This conidial form agrees with descriptions of *C. janthothele* var. *majus* Wollenw. the conidial form usually associated with *N. mammoidea* Phil. & Plowr.

Perithecia were common in cultures six to eight weeks old

Nectria tawa Dingley.

Conidia were not found among perithecia in field collections. Cultures are fulvous or cinnamon brown and floccose. Conidiophores are formed singly, rarely united to form pionnotes, sparsely branched, terminal phialides filiform, rather than flask-shaped. Conidia are cylindrical with rounded ends, 1-3 septate, occasionally 4-6 septate (1 septate 16-28 x 4.5-5 μ , 2 septate 23-36 x 4-5 μ ; 3 septate 30-45 x 5-7 μ). Microconidia are one or two-celled, often catenulated from a small lateral protuberance of the hypha, then aggregated into balls, 10-14 x 2.5-3.5 μ . Chlamydospores are globose, intercalary or in chains 10-15 μ diameter, with thickened pigmented walls (Text-fig. 3, 7). Perithecia are formed in cultures after six weeks.

Nectria westlandica Dingley

Dark vinaceous, translucent sporodochia are found among perithecia on host tissue. Cultures are amber, sometimes streaked with orange. Sporodochia and pionnotes are common, translucent, cream, 0.25-5 mm diameter. Conidiophores are penicillately and verticillately branched; conidia are catenulated from pyriform phialides, cylindrical, sometimes falcate, often elliptical or lanceolate, 1-5 septate, rarely 6 (3 septate 48-70 x 6-7 μ ; 5 septate 68-80 x 7-7.5 μ). Microconidia are common, sometimes catenulated from terminal phialides from conidiophores of young pionnotes; sometimes budded off from lateral protuberances of the hypha, then adhering together to form slimy spore balls 3-5.5 x 2.5-3 μ . Chlamydospores are absent (Text-fig. 3, 4).

3. Species with Conidia Typical of the Form Genus Fusarium

Species of this subsection fall within two groups:—

(a) Species with small, smooth perithecia, usually caespitose on a pseudoparenchymatous stroma, rarely scattered, and spores uniseriately arranged in the ascus.

Species studied in this group are *N. laeticolor* Berk. and Curt., *N. vilior* Starb. and *N. zealandica* Cke. In *N. laeticolor* macroconidia are classified in the section *Macroconia*. No macroconidia were formed in *N. vilior* but cultural characters are characteristic of *Fusarium*. In *N. zealandica* Cke. macroconidia are typical of the section *Roseum*.

(b) Species with tuberculate perithecia scattered rarely caespitose on a stroma; asci are more or less cylindrical, but spores are biseriately arranged at the apex of the ascus. Spores are lightly pigmented and striate. Included are *N. haematococca* Berk. and Br., *N. illudens* Berk., *N. pulverulenta* Dingley, and *N. plagianthi* Dingley. The conidial stage of these species falls within the section *Martiella* of *Fusarium*.

Nectria laeticolor Berk. & Curt.

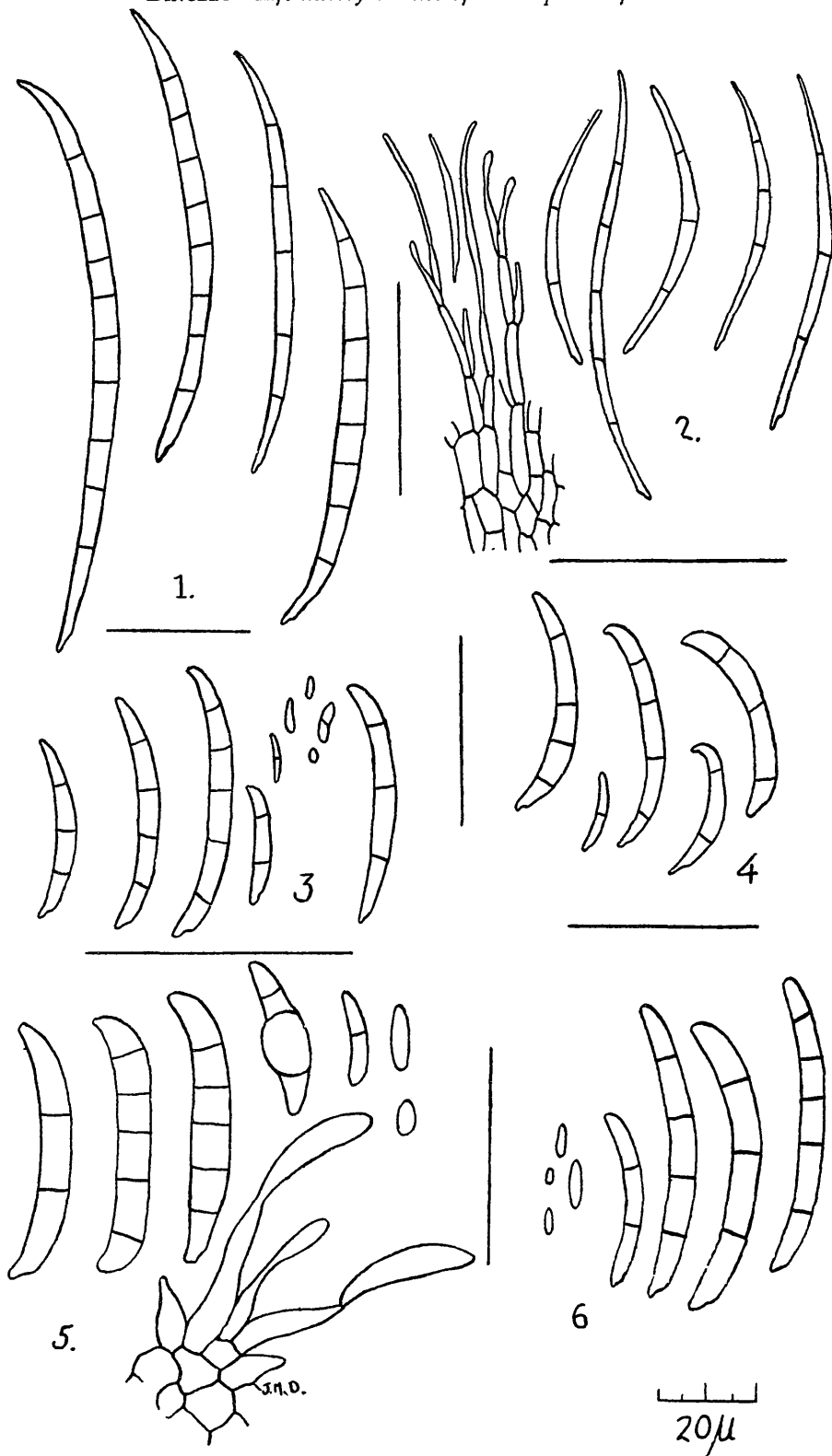
Both synnemata and sporodochia are present in field collections on scale insects. Cultures are white, sometimes floccose, slow growing and more or less pulvinate. Conidiophores mixed with sterile filamentous hyphae are united on a pseudoparenchymatous stroma, usually coral coloured. This stroma forms either synnemata or sporodochia. Conidia are subcylindrical, falcate, 3, but usually 5-8, rarely 9 septate, the apical cell is tapering and often curved, the basal foot cell attenuated. (5 septate 63-85 x 4-6 μ ; 6 septate 60-81 x 4.5-5.5 μ ; 7 septate 62-110 x 4-6 μ).—*Fusarium coccophilum* (Desm.) Wollenw. & Reink. (Text-fig. 4, 1). Sterile perithecia only were formed in cultures.

Nectria zealandica Cooke

Erumpent pulvinate sporodochia are found on bark of host, when fresh they are translucent and ochraceous but as perithecial formation takes place the stroma darkens. Cultures are floccose, often pigmented carmine, slow growing. Conidiophores are penicillately branched, terminating in phialides and borne on translucent sporodochia. Conidia are 3-5 septate, rarely 6-7 (3 septate 27-30 x 2.5-3 μ , 4 septate 45-76 x 3 μ ; 5 septate 48-75 x 2.5-3 μ), usually subcylindrical, falcate, with apical cells attenuated and foot cells elongated. Microconidia and chlamydospores are absent (Text-fig. 4, 2). Sterile perithecia were found in cultures 6-8 weeks old.

Nectria vilior Starback

No conidial stage has been found among perithecia in field collections. Single spore cultures are translucent, slimy, isabelline or pale salmon coloured. Macroconidia have not been found, but microconidia are either catenulated from terminal phialides on sparsely branched conidiophores, or budded off from protuberances on lateral walls of hyphae. They are elliptical, fusiform, cylindrical or allantoid, occasionally one-septate, otherwise unicellular, 4-9 x 1-2 μ . Chlamydospores are intercalary or terminal, single or in groups, sometimes one-septate, 4-10 x



TEXT-FIG. 4.—FIG 1.—Conidial forms of *N. laeticolor*. FIG. 2.—Conidial forms of *N. zealandica*. FIG. 3.—Conidial forms of *N. haematococca*. FIG. 4.—Conidial forms of *N. plaganthi*. FIG. 5.—Conidial forms of *N. pulverulenta*. FIG. 6.—Conidial forms of *N. illudens*.

2.5–5 μ . Perithecia are formed in some cultures four to six weeks old. Microconidia and cultural characters suggest a *Fusarium*, but as no macroconidia were formed the true nature of this conidial form could not be ascertained.

Nectria haematococca Berk. & Br.

Perithecia occur usually among a byssoid subiculum, pionnotes being present in the mycelium. Cultures are quick growing, pale vinaceous brown and usually floccose. Pionnotes and sporodochia up to 0.5 mm diameter and ochraceous, translucent, produced in zones. Conidia are cylindrical, almost straight although sometimes falcate, the apical cell rounded rather than curved, the foot cell not very pronounced, 1–7 septate commonly 3–5 septate (3 septate 25–40 x 4–5.5 μ ; 5 septate 40–60 x 5.5–7 μ). Microconidia non-septate, sometimes one-septate, 7–12 x 2–5 μ . Chlamydo-spores are terminal and intercalary, 7–10 μ diameter. Perithecia are formed in cultures 6–8 weeks old. This conidial form is named *Fusarium solani* (Mart.) App. & Wollenw. var. *sumartii* (Carp.) Wollenw (Text-fig 4, 3).

Nectria illudens Berk.

No conidial forms have been found in field collections. Cultures are quick growing, cream, more or less floccose, pionnotes and sporodochia are pale cream and formed in zones. Conidia are cylindrical, more or less falcate, the apical cell usually curved but often rounded, the foot cell poorly developed, 3–5 septate, occasionally 1–4 septate (3 septate 30–42 x 5–7.5 μ ; 5 septate 42–52 x 6–7 μ). Microconidia are elliptical or fusiform, 6–9 x 2.5–3 μ ; chlamydo-spores are rarely present (Text-fig. 4, 6). The cultural characters suggest that this conidial form could be treated as a form of *Fusarium solani* (Mart.) App. & Wollenw. Perithecia develop in cultures 4–6 weeks old.

Nectria plagianthi Dingley

No conidia have been found in collections on host plants. Cultures are quick growing, cream and floccose. Pionnotes and sporodochia are cream, translucent and produced in zones. Conidia are more or less cylindrical, usually falcate, the apical cell is curved, and a distinct foot cell is developed, 3–4–5 septate (3 septate 36–45 x 5.5–6 μ ; 4 septate 40–51 x 5–6.5 μ , 5 septate 45–52 x 5–6.5 μ). Microconidia are globose or pyriform, 6–15 x 3–4.5 μ . Chlamydo-spores are globose, 6–10 μ diameter (Text-fig. 4, 4).

Cultures are similar to those obtained from *N. illudens* but chlamydo-spores are common, microconidia are usually pyriform and macroconidia are narrower. This conidial form could also be treated as a variety of *Fusarium solani*.

Nectria pulverulenta Dingley

In field collections a white byssoid stroma is found upon which perithecia develop together with conidiophores with few conidia. Cultures are quick growing, cream and floccose. Pionnotes are pulvinate, translucent, and pale ochraceous. Conidia are arcuate rather than falcate, 3–4 rarely 5 septate (3 septate 45–52 x 5–6 μ ; 4 septate 40–56 x 5.5–7 μ). Microconidia, 9–12 x 1.5 μ are not very common. Chlamydo-spores are few but sometimes intercalary (Text-fig 4, 5).

As with that of other species discussed in this group the conidial stage could be regarded as a variety of *F. solani*

DISCUSSION

In five species studied in Section I conidia formed in young cultures are characteristic of the form genus *Verticillium*; in older cultures, however, conidiophores are united on sporodochia typical of *Dendrodochium*. The relationship of these form genera with species of *Nectria* showing distinct perithecial structures suggest that if a division of *Nectria* is to be made both characters should be used to separate the groups. Wollenweber (1926) based a subdivision of *Nectria* on conidial forms and placed species with unicellular conidia into the group *Microconnectria*. He divided this group into sub-sections according to the type of unicellular conidia, i.e., *Hyphonectria* included species with a *Cephalosporium* conidial form; *Dendrodochiella* for species with a *Dendrodochium* conidial form; *Chilonectria* for species with microconidia budded direct from ascospores; and *Tuberculariastrum* for species with a *Tubercularia* conidial form. As he neglected to consider these forms in relationship to morphology of the perithecia, he included in these subsections groups of species with distinctly different perithecial structures.

The species studied in Section II showed no correlation, and suggests that species included therein are not related. *N. peziza* and *N. cyathea* produced microconidia

only whereas *N. otagensis*, *N. macrostoma* and *N. ralfsii* produced definite conidial forms. Morphologically, the perfect stage of *N. otagensis* can be separated from other species of *Nectria* since perithecia are more or less immersed in a prosenchymatous stroma. In *N. macrostoma* perithecia possess a byssoid prosenchymatous outer wall while hyphae of the sub-hymenial layer are pigmented and thickened. Perithecia of *N. ralfsii* show a typical pseudoparenchymatous outer wall, but pigment globules are present in and among mycelium of the sub-hymenial layer. Developmental studies of perithecia of these species would probably show whether they should be retained under *Nectria*.

In Section II there are few morphological differences in perithecial structure of species which produce *Tubercularia*, *Cylindrocarpon* and *Fusarium* conidia. Species with *Cylindrocarpon* conidial forms are associated with dark coloured, usually vinaceous brown, perithecia arising from compacted, thickened, and pigmented cells of the outer pseudoparenchymatous wall. In other features perithecia of this group are typical of the genus *Nectria* Fr. as defined by the type *N. cinnabarina*.

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JOAN M. DINGLEY, M.Sc.,
Plant Diseases Division,
Private Bag, Auckland.