

The Hypocreales of New Zealand. I

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THE Hypocreales are fungi belonging to the Ascomycetes, as their sexual spores are developed in an ascus. As in the Sphaeriales, the asci are borne in a well-developed perithecium. The perithecial walls are fleshy, often membranous, but not dark coloured, hard or brittle. Paraphyses are absent from the ascogenous tissue, although pseudo-paraphyses are present within the perithecium. For many years this order has been separated from the Sphaeriales by its fleshy perithecia. Recent work by Miller (1949) based on developmental studies of *Sphaerostilbe aurantiicola* (Berk and Br.) Petch by Luttrell (1944) has shown that tissue formed within the perithecium prior to the development of the asci become, in the mature perithecium, evanescent, but remain as vertical or irregularly developed filaments often arising from the apex of the perithecium. Seeler (1940) in discussing the genus *Thyronectria* stated that paraphyses were lacking, but that evanescent branching filaments were sometimes present. He observed that these filaments differ from paraphyses as they grow downwards from the position later occupied by the ostiole and fill the perithecial cavity with a gelatinous substance. These observations agree with those published by Luttrell. Examination of New Zealand material has shown that paraphyses were absent, but evanescent tissue within the perithecium was present in some species, even in those genera, e.g. *Claviceps* and *Cordyceps*, that Nannfeldt (1932) included in the family Clavicipitaceae. In this present account this family has been retained in the Hypocreales, not in the Sphaeriales, the position suggested for it by Miller.

Seaver (1909), in his treatment of the North American Hypocreales, and Petch (1938) the British Hypocreales, divided the order into two families, Nectriaceae and Hypocreaceae, on stromatic and perithecial characters. Spore characters were retained by both for generic and specific separation. Throughout the New Zealand species studied, stromatic characters varied with the substratum, therefore this separation between the families Hypocreaceae and Nectriaceae was dropped. Ascal characters as defined by Nannfeldt were used to separate the families Hypocreaceae and Clavicipitaceae. Spore characters were used for generic and specific separation.

MORPHOLOGY

Perithecia and stroma are superficially arranged on the host substratum. When the stroma is absent, perithecia are scattered freely on the host tissue, but if a stroma is present, the perithecia are caespitose or gregariously arranged, sometimes completely immersed in the stromal tissues. The stroma is pulvinate, sometimes erumpent, or effuse.

Throughout the order perithecia possess a well-defined wall, usually pseudoparenchymatous, but in some species the mycelial walls are densely thickened and pigmented and the nature of the tissue of the perithecial wall is difficult to discern. In other species pigmented inclusions within the cells gave colour to the perithecium. Where perithecia are immersed in the stromal tissues, the perithecial wall is poorly developed, but it is always distinct. An ostiolum is always present, usually papillate and lined with periphyses. The stroma varies from a loosely aggregated mat of mycelium to a well-developed pulvinate pseudoparenchymatous structure.

Asci develop from ascogenous hyphae at the base of the perithecium. They typically contain eight spores, although in some genera, the spores fragment within the ascus to form numerous part-spores. Within the order asci are divided into two types according to the method in which the spores are liberated.

- (a) No special mechanism is associated with the liberation of spores. The wall at the apex of the ascus ruptures and mature spores are freed. Asci are thin walled, clavate, cylindrical or elliptical, typical of asci of the family Hypocreaceae.
- (b) The contents of the mature ascus force off a definite cap or apical segment similar to the operculum in asci of the Pezizales. Asci are cylindrical and thick walled, truncate and thickened at the apex. This condition is characteristic of the family Clavicipitaceae.

Paraphyses are absent; it is possible that earlier records of paraphyses were based upon misidentification of pseudoparaphyses or young asci.

Spores may be non-septate, uniseptate, multiseptate or muriform. In some genera the spores fragment at the septa to form unicellular part spores. They are typically hyaline, although lightly pigmented spores are characteristic of some species.

In New Zealand few groups of the Ascomycetes have been studied. In Hooker's *Handbook to the New Zealand Flora*, published in 1867, two species of *Nectria*, one *Hypocrea* and two species of *Cordyceps* were listed and briefly described. Cooke (1879) listed and described a few further collections sent to Kew from New Zealand. Cunningham (1921) described species in the genus *Cordyceps*.

The present treatment is by no means complete, as collecting has not been sufficiently extensive throughout the Dominion.

Family I. HYPOCREACEAE

Perithecia light or brightly coloured, walls pseudoparenchymatous, fleshy or membranous, rarely dark coloured, never hard or brittle; perithecia scattered or aggregated on or immersed in a stroma. Asci not operculate, spores liberated by rupturing of apical wall of ascus. Paraphyses absent.

KEY TO GENERA

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|--|----|----|---------------------|
| Ascospores one-septate | | | |
| Spores elliptical or fusiform, apiculate | .. | .. | 1. <i>Hypomyces</i> |
| Spores oval, elliptical or fusiform, not apiculate | .. | .. | 2. <i>Nectria</i> |
| Ascospores one septate fragmenting into unicellular part-spores within the ascus | .. | .. | 3. <i>Hypocrea</i> |

Ascospores multiseptate.

Spores with two or more transverse septa.

Perithecia red or lightly coloured 4. *Calonectria*

Perithecia violet or black 5. *Gibberella*

Spores muriform 6. *Thyronectria*

Hypomyces includes species with fleshy, often brightly coloured perithecia, superficial or semi-immersed in an effuse subiculum. Spores are one-septate, fusiform, apiculate and coarsely verrucose. Most species parasitize other fungi. Although originally defined to include only species with one-septate fusiform, apiculate spores, the genus for a time was treated as a biological one to include all *Nectria*-like fungi which parasitize other fungous fructifications. To-day the genus is limited to its original definition. Sydow (1920) separated species with unequally divided spores into the genus *Apiocrea*, but this character seems too variable to justify this treatment, consequently all species are included in *Hypomyces*. Species with smooth, elliptical or oval one-septate spores are placed under *Nectria*.

Hypomyces Tulasne. *Annales des Science Naturelles*, ser. iv, vol. 13, p. 11, 1860.

Clintoniella (Sacc) Rehm. *Hedwigia*, vol. 39, p. 223, 1900 (in part);

Apiocrea Sydow. *Annales Mycologici*, vol. 18, p. 186, 1920.

Perithecia superficial or immersed in an effuse, byssoid stroma; perithecial wall pseudoparenchymatous, pigmented and hyaline. Asci containing eight spores, paraphyses absent. Spores one-septate, fusiform, apiculate, verrucose, hyaline or lightly pigmented.

Type Species. *Hypomyces lactifluorum* Schw.

Distribution. World wide.

KEY TO SPECIES

Spores under 30μ in length.

Spores equally divided by septa.

Perithecia globose; spores $17-26 \times 4-6\mu$ 1. *H. aurantius* Tul.

Perithecia pyriform; spores $26-30 \times 4-6\mu$ 2. *H. rosellus* (Alb. & Schw.) Tul.

Spores unequally divided by septa 3. *H. chrysospermus* Tul.

Spores over 30μ in length.

Perithecia superficial; spores $27-45 \times 4-6\mu$.. 4. *H. novae-zealandiae* Dingley

Perithecia immersed in byssoid stroma; spores $27-38 \times 5-7\mu$ 5. *H. armeniacus* Tul.

1. **Hypomyces aurantius** (Persoon) Tulasne. *Selecta Fungorum Carpologia*, vol. 3, p. 48, 1865. (Plate 10, Fig. 3.)

Sphaeria aurantia Pers *Synopsis Fung.*, p. 18, 1801; *S. aurantia* Pers. ex Fr. *Syst. Myc.*, vol. 2, p. 440, 1823; *Nectria aurantia* Fr. *Summa Veg. Scand.*, p. 388, 1849.

Subiculum effuse, spreading over pileus of host, orange and umber, margins floccose, light yellow or white, pigment granules present on outer wall of mycelium; perithecia gregarious, crowded, superficial or semi-immersed in subiculum, globose or oval, $0.2-0.3 \times 0.4$ mm., orange or ferruginous, translucent, ostiole papillated; perithecial wall pseudoparenchymatous, 50μ thick, cells $8-15 \times 12-25\mu$, thin walled, lightly pigmented, pigmented granules present among the cells. Asci cylindrical, ends truncate, thin-walled, $80-140 \times 4-6\mu$, 8 spored, spores obliquely uniseriate. Spores one-septate, equally divided into two cells, fusiform, slightly curved, apiculate, $17-26 \times 3-6\mu$ hyaline and verrucose.

Type Locality: Europe.

Distribution: Europe, North and South America, West Indies, Australia, New Zealand.

Habitat: On fructifications of Polyporaceae. *Coriolus velutinus* (Pers. ex Fr.) Quel. Auckland, Mount Albert, September, 1948, D. W. McKenzie. *Fomitopsis hemitephrus* (Berk.) G. H. Cunn. Otago, Otautau, December, 1946, G. B. Rawlings (2 col.). *Irpeix brevis* Berk. Auckland, Waipoua, September, 1949, Joan M. Dingley. *Poria* sp. Auckland, Clevedon, August, 1948, Joan M. Dingley.

A distinct species, easily recognised by its bright orange, effuse subiculum which covers the pileus of the host. Perithecia are darker coloured but translucent. Colenso (1886) first recorded this species for New Zealand from material collected in Hawke's Bay and determined at Kew by M. C. Cooke.

No conidial stage is present, but Petch (1938) described *Diplocladium penicillioides* Sacc. as its conidial form. The spores are borne on a stalked head or phialides, conidia are one-septate, $9-16 \times 6-9\mu$, hyaline. He also described chlamydospores $18-48 \times 12-18\mu$, one- to three-septate, reddish-brown.

2. *Hypomyces rosellus* (Alb. and Schw.) Tulasne. *Annales des Science Naturelles*, ser. iv, vol. 13, p. 12, 1860. (Plate 10, Fig. 6.)

Sphaeria rosella Alb. and Schw. *Conspect. Fung.*, p. 35, 1805; *S. rosella* Alb. and Schw. ex Fr. *Syst. Myc.*, vol. 2, p. 441, 1822.

Subiculum effuse, white or rose coloured, mycelium compacted into a pseudoparenchymatous layer 0.3 mm. thick, hyphae thin-walled and lightly pigmented. Perithecia gregarious, superficially arranged, pyriform, $0.2-0.25 \times 0.3$ mm., collapsing when dry, ostiole papillated, hairy, rose or vinaceous coloured; perithecial wall pseudoparenchymatous, 40μ thick, cells $8-14\mu$ diameter, rectangular or cuboid, cell walls pigmented. Asci cylindrical, ends truncate, thin walled, $90-200 \times 4-6\mu$, 8 spored, uniseriate, sometimes obliquely arranged. Spores uniseptate, equally divided into two cells, fusiform or elliptical, apiculate, occasionally allantoid, $26-30 \times 4-6\mu$, hyaline or verrucose. Conidial stage: Conidia elliptical or obtuse, sometimes allantoid, 1-3-septate, $16-28 \times 7-10\mu$, smooth, hyaline, sometimes constricted at septa. Conidiophores verticilloid or irregularly arranged on upright hypha *Dactylium dendroides* Fr., *Syst. Myc.*, vol. 3, p. 413, 1829.

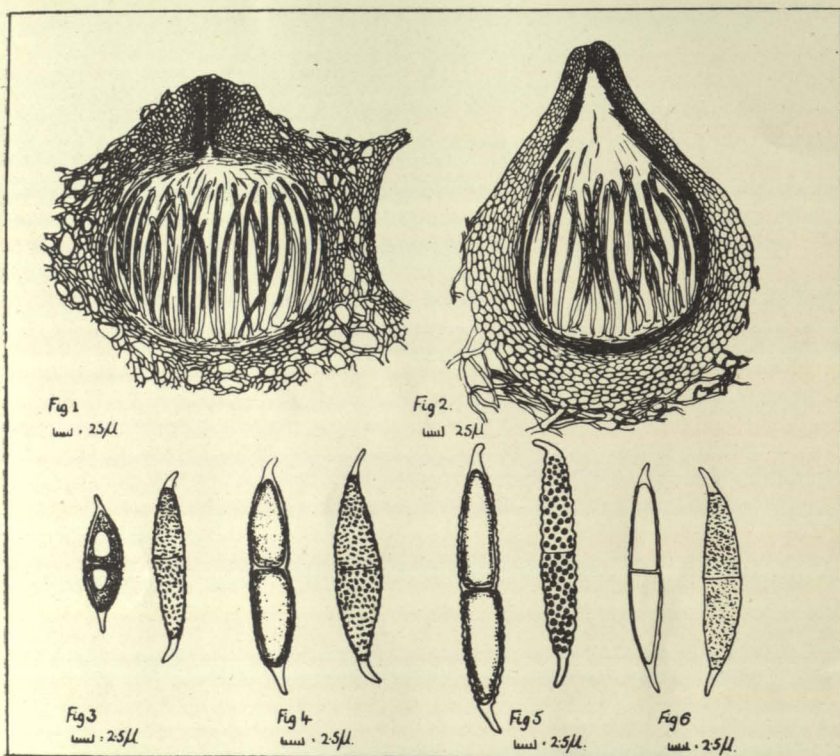
Type Locality: Germany.

Distribution: North and South America, West Indies, Australia, New Zealand.

Habitat: On decaying fungus fructifications. *Polyporus* sp. Auckland, Waitakere Ra., off Anawhata Rd., 1,000 ft., August, 1948, Joan M. Dingley. *Unknown host*. Auckland, Otago, May, 1949, Joan M. Dingley; Wellington, Weraroa, August, 1919, G. H. Cunningham.

Seaver (1910) described two conidial forms, a species of *Trichothecium* as well as a *Dactylium* sp.

The Wellington collection was determined by C. G. Lloyd as *Clintoniella rosella* (Alb. and Schw.), *Clintoniella* being erected by Saccardo (1883) as a sub-genus of *Hypocrea* to include forms with one-septate spores and an effuse stroma. According to Hoehnel (1918) Rehm raised Saccardo's sub-genus to generic rank, citing *H. apiculata*





Peck as the type species. At this time some workers still regarded *Hypomyces* as a biological genus and included in the genus *Clintoniella* species morphologically similar to *Hypomyces*, but which did not appear to parasitize other fungi. Seaver (1910) examined the co-type of Peck's type species, *Hypocrea apiculata*, and found it to be typical of the genus *Hypomyces* and listed Rehm's genus *Clintoniella* as a synonym. Hoehnel (*ibid.*) examined species within Saccardo's sub-genus and found them to belong to different genera within the Hypocreaceae.

3. ***Hypomyces chrysospermus*** Tulasne. *Annales des Sciences Naturelles*, ser. iv, vol. 13, p. 16, 1860.
Apiocrea chrysosperma (Tul.) Sydow. *Annales Mycologici*, vol. 18, p. 187, 1920.

Subiculum effuse, floccose, white, mycelium thin walled, hyaline. Perithecia gregarious, semi-immersed or superficial, globose, or oval, 0.2–0.3 mm. diameter, light yellow, brown when dry, ostiole papillated; perithecial wall pseudoparenchymatous, 20–25 μ thick, cells 5–7 μ diameter, rectangular or cuboid, thin-walled and lightly pigmented. Asci cylindrical, thin-walled, apex truncate, 90–120 \times 4–6 μ , 8-spored, obliquely uniseriate. Spores one-septate, cells unequal, elliptical, fusiform and apiculate, 14–24 \times 4–6 μ , verrucose and hyaline. Chlamydospores globose, thick-walled, 16–20 μ , tuberculate and yellow. *Sclerodinium chrysospermum* (Bull.) Fr. *Syst. Myc.*, vol. 3, p. 438, 1829.

Type Locality: France.

Distribution: Europe, North America, Australia, New Zealand.

Habitat: Parasitic on fructifications of *Boletus* sp. Auckland, Waitakere Ra., Titirangi, June, 1946, Myra W. Carter; Swanson, May, 1948, Joan M. Dingley; Little Barrier Island, November, 1947, Joan M. Dingley.

The bright yellow colour of the chlamydospores give the immature subiculum a characteristic colour. Perithecia are rarely mature before the pileus of the host has collapsed. Although not all spores are unevenly divided by the septa all microscopic preparations contain both evenly and unevenly divided spores. Petch (1938) described a conidial stage as follows: "white effuse conidia, pyriform or oblong oval, slightly constricted in the middle, continuous becoming one or two septate 10 \times 5 μ to 30 \times 12 μ ; conidiophore irregularly verticilliod, often clustered."

4. ***Hypomyces novae-zealandiae*** n.sp.* (Plate 10, Figs. 2, 5.)

Subiculum effusum, album, byssoidum. Perithecia gregaria in subiculo, superficialia, globosa, vel pyriforma, 0.3–0.5 mm. lutea, ostiolium papillatum. Asci cylindrici, truncati 70–200 \times 4–6 μ . Sporae uni-septatae, fusiformae, apiculatae 27–45 \times 4–6 μ , hyalinae verrucosaeque.

Subiculum effuse, white, pale yellow, byssoid, mycelium pale coloured. Perithecia gregarious, superficial, rarely semi-immersed in stroma, globose sometimes pyriform, 0.3–0.5 mm., luteous or sulphur yellow, translucent when fresh, ostiole papillated; perithecial wall

* I am indebted to Marjorie Newhook for the Latin translation.

pseudoparenchymatous 30–40 μ thick, cells rectangular or cuboid 5–10 μ diameter, thin-walled, lightly pigmented yellow. Asci cylindrical, thin-walled, truncate 70–200 \times 4–6 μ , 8-spored, uniseriate. Spores one-septate, equally divided into two cells, fusiform, apiculate 27–45 \times 4–6 μ , hyaline and verrucose.

Type Locality: Waitakere Range, Auckland.

Distribution: New Zealand.

Habitat: On pileus of *Polyporus* sp. Auckland, Waitakere Ra., off Anawhata Rd., August, 1947, Joan M. Dingley. Type collection.

This species is separated from *H. armeniacus* Tul. by the superficially arranged yellow perithecia and large fusiform spores. In growth form it is similar to *H. rosellus*, but spores are much larger and perithecia yellow, instead of red.

5. ***Hypomyces armeniacus*** Tulasne L. R. *Annales des Science Naturelles*, ser. iv, vol. 13, p. 12, 1860. (Plate 10, Figs. 1 and 4.)
Hypomyces ochraceus (Pers.) Tul., *Sel. Fung. Carp.*, vol. 3, p. 61, 1865;
Hypocrea apiculata Peck, *29th Rep. N.Y. State Mus.*, p. 75, 1878;
Hypomyces terrestris Plowr. and Boud., *Grevillea*, vol. 8, p. 105, 1880;
Hypomyces apiculatus (Peck) Seaver, *Mycologia*, vol. 2, p. 73, 1910;
H. macrosporus Seaver, *Mycologia*, vol. 2, p. 80, 1910

Subiculum effuse, completely obliterating gills of host pileus, pale flesh coloured, or ochraceous, mycelium compacted, hyaline. Perithecia gregarious, completely immersed in subiculum, globose or oval 0.3–0.4 \times 0.4–0.5 mm., ochraceous or flesh coloured, ostiole papillated, translucent, perithecial wall pseudoparenchymatous 20 μ thick, cells thin-walled, lightly pigmented. Asci cylindrical 120–160 \times 5–8 μ , 8-spored, uniseriate, sometimes obliquely arranged. Spores one-septate, fusiform with ends apiculate 25–38 \times 5–7 μ , verrucose, sometimes constricted at septa, pale yellow.

Type Locality: France.

Distribution: Europe, North America, New Zealand.

Habitat: On pileus of Agarics. *Lactarius* sp. Wellington, Levin, October, 1919, E. H. Atkinson.

Petch (1938) described a conidial stage for this species, *Verticillium agaricinum* Corda, with conidia obovate 11–21 \times 9–12 μ or globose 10–13 μ ; he also recorded chlamydospores *Blastotrichum puccinioides* Preuss, as compound 2–4 septate with large central cells 70–140 \times 24–33 μ reddish-purple and smooth. These stages were not observed in the New Zealand collections.

Confusion exists as to the correct name of this species. Maire (1911) concluded that after examining Tulasne's type collection of *H. armeniacus* this species agreed with Seaver's *H. macrosporus*. Seaver (1910) noted that his species *H. macrosporus* was probably *H. ochraceus* (Pers.) Tul., but Persoon's material was not available for comparison. Maire (*ibid.*) stated that Tulasne in *Selecta Fungorum Carpologia* (1865) changed the name of *H. armeniacus* to *H. ochraceus* presumably to identify the species with *Sphaeria ochracea* Pers., although Tulasne himself was doubtful that these species were synonymous. Fries (1822) listed *Sphaeria ochracea* as a variety of *S. citrina* (*Hypocrea citrina* Fr.). Petch (1937) neglected Maire's work and referred this species to *Hypomyces ochraceus* (Pers.) Tul., listing

Sphaeria ochracea Pers. as a synonym. *H. terrestris* Plow. and Boud. was, according to Petch, erected because the authors did not realise that the perithecial stage of this fungus seldom developed until the agaric had completely disintegrated and concluded that the species was always found parasitic on the agaric and never terrestrial. In other respects these species are identical. Petch also stated that Miss Wakefield of Kew had determined that *H. apiculatus* (Peck) Seaver was identical with Plowright's species.

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FIG. 1—*H. armeniacus*
 FIG. 2—*H. novae-zelandiae*
 FIG. 3—*H. aurantius*

FIG. 4—*H. armeniacus*
 FIG. 5—*H. novae-zelandiae*
 FIG. 6—*H. rosellus*