Harorepupu aotearoa (Onygenales) gen. sp. nov.; a threatened fungus from shells of Powelliphanta and Paryphanta snails (Rhytididae)

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Abstract: A cleistothecial fungus, known only from the shells of giant land snails of the family Rhytididae, is described as a new genus and species within Onygenales, Harorepupu aotearoa gen. sp. nov. Known only from the sexual morph, this fungus is characterized morphologically by a membranous ascoma with no appendages and ascospores with a sparse network of ridges. Ribosomal DNA sequences place the new species within Onygenales, but comparison with the known genetic diversity within the order linked it to no existing genus or family. It is the first species of Onygenales reported from the shells of terrestrial snails. This fungus has been listed as Critically Endangered in New Zealand and has been previously referred to as ‘Trichocomaceae gen. nov.’ in those threat lists.

INTRODUCTION

Few fungi have been reported from the shells of terrestrial snails compared to aquatic snails (Říhová et al. 2014). In a survey of fungi associated with empty shells of Cepaea hortensis, Říhová et al. (2014) reported 27 species, mostly common soil fungi. They found few potentially keratinolytic species and concluded that the fungi they detected were likely to be accidental colonisers rather than specialist shell decomposing fungi. Snail shells have a layer of calcium carbonate covering a core of conchiolin, a keratin-like compound very resistant to decay (Ormsby et al. 2006, Goffer 2007).

Říhová et al. (2014) mentioned a report on the NZFungi database (http://nzfungi2.landcareresearch.co.nz/) of a species of Trichocomaceae reported from shells of Powelliphanta and Paryphanta species in New Zealand. These snails are members of the family Rhytididae (Mollusca; Gastropoda, Pulmonata), the thick shells of which are composed almost entirely of conchiolin with only thin outer layers of calcium carbonate (Ormsby et al. 2006). Hitchmough (2002) listed this fungus as ‘Undescribed genus, Trichocomaceae’ and accorded it a Nationally Critical threat status. The same fungus has been mentioned in Department of Conservation reports (e.g. Anon. 2007, Miller & Holland 2008).

The tentative NZFungi identification of the fungus on Powelliphanta and Paryphanta as Trichocomaceae was based on the macroscopic appearance of the ascomata and ascospore morphology. An asexual morph has not been observed. Trichocomaceae is a family in Eurotiales, some species of which have sexual morphs similar to those of Onygenales, the two orders being most easily distinguished morphologically by their asexual morphs (Currah 1994). Currah (1994) notes that amongst these fungi, the keratin degrading species are restricted to the families Onygenaceae and Arthrodermataceae within Onygenales. Of these two families, the fungus on Powelliphanta and Paryphanta is morphologically similar to Onygenaceae sensu Currah (1985). Two fungi reported from cultures derived from Cepaea shells by Říhová et al. (2014) were identified using DNA sequences as Onygenales, but the sequences for these are not available.

In this paper we describe the fungus associated with Powelliphanta and Paryphanta shells as a new genus within Onygenales incertae sedis, its phylogenetic position being based on SSU, ITS and LSU sequences. We compare it with the known genetic diversity within the order.

MATERIALS AND METHODS

Morphology

Fungarium specimens were rehydrated in 3 % KOH and the hymenial elements examined microscopically in either 3 % KOH or 3 % KOH mixed with Lugol’s iodine solution. Vertical sections were cut at a thickness of about 10 µm using a freezing microtome and mounted in lactic acid. Material for scanning electron microscopy (SEM) was obtained by placing a mass of dried ascospores onto carbon tape on a stub, then sputter coating with gold. Photomicrographs taken on a Jeol Neoscope JCM-5000 (Landcare Research). Specimens have been deposited in PDD.

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Molecular analyses

For DNA extraction, three separate extractions were done from three different ascomata from PDD 105262. DNA was extracted and amplified using a REExtract-N-Amp Plant PCR Kit (Sigma-Aldrich, USA), following the manufacturer’s protocol except that the ascomata were ground in 30 µL extraction solution with a plastic pestle. Amplification primers for ITS were ITS1F and ITS4 (White et al. 1990; Gardes & Bruns 1993), for LSU were LR0R and LR5 (Bunyard et al. 1994; Vilgalys & Hester 1990), and for SSU were NS1 and NS4 (White et al. 1990).

Additional sequence data of SSU, LSU and ITS were downloaded from GenBank (Table 1). Sequences of each gene were aligned with MAFFT 7.122b (Katoh & Standley 2013) and trimmed with BioEdit (Hall 1999). Alignments were deposited in TreeBASE (www.treebase.org/treebase/), study accession number 17085. Molecular phylogenies were constructed using Bayesian inference (BI) and maximum likelihood (ML) to select the most appropriate model of sequence evolution, jmodeltest 2.1.1 (Darriba et al. 2012; Guindon & Gascuel 2003) was applied on each alignment (ITS, SSU, LSU). The GTR + I + G model was selected for ITS, SSU, and LSU according to the Akaike information criterion (AIC). The SSU and LSU matrices were concatenated with SeaView (Gouy et al. 2010). BI analyses were performed with MrBayes 3.2 (Ronquist & Huelsenbeck 2003). Three independent Markov chain Monte Carlo (MCMC) runs were performed simultaneously. Each MCMC ran for 3 x 10^6 generations for the SSU+LSU analysis and the ITS analysis, sampling every 500 generations until convergence (standard deviation of split frequency < 0.01). The first 25 % of trees were discarded as burn-in while the remaining trees were combined with a 50 % majority rule consensus. ML analyses were performed with phyML 3.0 (Guidon et al. 2010) running inside SeaView (Gouy et al. 2010) with the following options: GTR model; aLRT branch support; empirical nucleotide equilibrium frequencies; optimized invariable site; optimized across site rate variation with 8 rate categories; NNI tree searching operations; BioNJ starting tree with optimized tree topology.

TAXONOMY

Harorepupu P.R. Johnst., H.D.T. Nguyen, D.C. Park, & Hirooka, gen. nov.
MycoBank MB811561

Etymology: From the Māori words harore = fungus, and pūpū = snail (fem.).

Diagnosis: Ascomata globose, sessile, membranous, solitary or in small, confluent groups; asci subclavate, wall undifferentiated; ascospores hyaline, oblong-elliptic, ornamented with anastomosing ridges.

Type: Harorepupu aotearoa P.R. Johnst. et al. 2015.

Harorepupu aotearoa P.R. Johnst., H.D.T. Nguyen, D.C. Park, & Hirooka, sp. nov.
MycoBank MB811562 (Fig. 1)

Etymology: The species epithet is from the Māori word for the country of origin.

Diagnosis: Ascomata 0.8–1.2 mm diam, white to pale yellow; asci 13–16 × 7.5–8.5 μm, 8-spored; ascospores 4.2–5.4 × 2–3.1 μm (average 4.8 × 2.6 μm), oblong-elliptic, ends rounded, sparse network of narrow, ridge-like ornamentations.

Type: New Zealand: Nelson: Golden Bay, Wainui Falls Tr., on empty shell of Powelliphanta sp., 16 May 2014, P.R. Johnston FUNNZ 2014/0999 (PDD 105262 – holotype).

Description: Ascomata 0.8–1.2 mm diam, globose, sessile, membranous, surface slightly woolly but with no distinctive appendages, white to pale yellow; Opening by irregular cracks, revealing the dry, powdery, bright yellow spore masses inside; wall 80–100 μm thick, comprising tightly tangled hyphae 4–6 μm diam, walls thin, mostly hyaline, outer 3–4 rows of cells sometimes with pale yellow walls; outermost layers of hyphae sometimes with ends free; peridial appendages lacking. Asci 13–16 × 7.5–8.5 μm, clavate with a narrow, foot-like base and rounded apex, wall thin, undifferentiated, 8-spored, contents orange-brown in Lugol’s iodine. Ascospores 4.0–5.5 × 2–3 μm (average 4.8 × 2.6 μm), oblong-elliptic, ends rounded, ornamented with sparse network of narrow, anastomosing ridges, hyaline to pale yellow, 0-septate. Asexual morph not seen.

Additional specimens examined: New Zealand: Nelson: vic. Karamea, Kohaihai, Nikau Walk, on empty shell of Powelliphanta sp., 11 May 1994, P.R. Johnston (PDD 74629); vic. Karamea, Oparara Basin, Moria Gate Track, on empty shell of Powelliphanta sp., 10 May 2006. T. Atkinson FUNNZ 2006/1066 (PDD 92048); vic. Westport, Charming Creek Walkway, on empty shell of Powelliphanta sp., 10 May 2006 A. Wilson FUNNZ 2006/0160 (PDD 89035). Northland: Waipoua Forest, on empty shell of Paryphanta sp., 2001, E. Horak, (PDD 74625).

RESULTS

DNA sequences from all three ascomata from PDD 105262 were identical. They have been accessioned as GenBank KP683349, KP683350, and KP683351.

Phylogenetic analyses with the combined SSU + LSU sequences was performed to determine the higher taxonomic placement of Harorepupu aotearoa. After removing ambiguously aligned regions, SSU and LSU alignments were both 1300 base pairs long and contained a total of 257 (20 %) and 421 (32 %) parsimony informative characters respectively. Both the BI analysis (Fig. 2) and ML analysis (not shown) placed H. aotearoa in an isolated position in Onygenales. To determine whether we could place it in a well-supported family in Onygenales, we then performed phylogenetic analyses of the ITS region, with an
Harorepupu aotearoa gen. sp. nov. (Onygenales) from snail shells

Fig. 1. Harorepupu aotearoa. A. Ascomata on shell, arrows indicate groups of ascomata on host shell (PDD 105262). B. Detail from A. C. Ascoma with wall breaking to expose powdery mass of yellow spores inside (PDD 74629). D. Asci in 3 % KOH plus Lugols iodine (PDD 74629). E. Ascomatal wall in vertical section (PDD 89035). F. Surface of ascoma (PDD 105262). G–I. Ascospores under light microscope, at three planes of focus (PDD 105262). J. Ascospores under SEM (PDD 105262). Bars: A, B = 10 mm; C = 0.5 mm; D, G–J = 10 μm; E–F = 20 μm.
Table 1. Species, culture, or voucher numbers, and GenBank accession numbers of isolates used in the phylogenetic analyses.

| Genus and species                     | Strain Number  | 18S Accession     | 28S Accession     | ITS Accession     |
|---------------------------------------|----------------|-------------------|-------------------|-------------------|
| Roccellographa cretacea               | AFTOL-ID 93    | DQ883705          | DQ883696          | —                 |
| Dendrographa decolorans              | DUKE 47570     | NG_013155         | NG_027622         | —                 |
| Ramularia endophylla                 | AFTOL-ID 942 = CBS 113265 | DQ471017          | DQ470968          | —                 |
| Dothidea insculpta                   | CBS 189.58 = AFTOL-ID 921 | NG_016493         | NG_027643         | —                 |
| Arachnomycos glareosus               | CBS 116129     | FJ358341          | FJ358273          | —                 |
| Arachnomycos kanei                   | UAMH 5908      | AF525308          | —                 | —                 |
| Arachnomycos minimus                 | CBS 324.70     | FJ358342          | FJ358274          | —                 |
| Capronia pilosella                   | AFTOL-ID 465   | DQ823106          | DQ823099          | —                 |
| Cyphellophora lacinata               | AFTOL-ID 1033  | EF413618          | EF413619          | —                 |
| Exophiala piscipila                  | AFTOL-ID 669   | DQ823108          | DQ823101          | —                 |
| Calicopsis orientalis                | AFTOL-ID 1911 = CBS 658.74 | DQ471039          | DQ470987          | —                 |
| Calicopsis pinea                     | AFTOL-ID 1869  | DQ678043          | DQ678097          | —                 |
| Monascus purpurus                    | AFTOL-ID 426   | DQ782881          | DQ782908          | —                 |
| Xeromycos bisporus                   | CBS 236.71     | FJ358355          | FJ358291          | —                 |
| Byssochlamys nivea                   | CBS 100.11     | FJ358345          | FJ358279          | —                 |
| Penicillium javanicum                | AFTOL-ID 429   | EF413620          | EF413621          | —                 |
| Chaenothecopsis savonica             | Tibell 15876   | U68691            | AY796000          | —                 |
| Mycocalicium polyporaem              | ZWGeo60Clark   | AY789361          | AY789362          | —                 |
| Stenocye pufata                      | Tibell 17117   | U68692            | AY796008          | —                 |
| Sphinctrina turbinata                | AFTOL-ID 1721  | EF413631          | EF413632          | —                 |
| Ajellomyces capsulatus               | ATCC 26032     | AF32009           | —                 | —                 |
| Ajellomyces capsulatus               | CBS 136.72     | —                 | AB176497          | —                 |
| Ajellomyces capsulatus               | UAMH 7141      | —                 | AF038353          | —                 |
| Ajellomyces dermatitidis             | ATCC 18187     | —                 | AY176704          | —                 |
| Ajellomyces grisea                   | CBS 128.88 = UAMH 5409 | AB075361         | —                 | —                 |
| Histoplasma capsulatum var. duboisii | ATCC 18910 = CBS 423.74 = IMI 135822 | —       | —             | HQ825139          |
| Ctenomyces serratus                  | CBS 187.61     | FJ358347          | FJ358282          | AJ877222          |
| Epidermophyton floccosum             | CBS 230.76     | Z34923            | —                 | —                 |
| Keratinomyces cereticus              | CBS 269.89     | —                 | —                 | AJ877224          |
| Microsorum audouinii                 | CBS 109478     | GU733362          | —                 | —                 |
| Microsorum audouinii                 | ATCC 10216     | —                 | EF078482          | —                 |
| Microsorum ferrugineum               | CBS 427.63     | —                 | —                 | AJ252336          |
| Trichophyton equinum                 | CBS 112198     | —                 | EF043275          | —                 |
| Trichophyton rubrum                  | CBS 118892     | JX431933          | JX431933          | —                 |
| Trichophyton rubrum                  | UAMH 8547      | —                 | —                 | AF170471          |
| Ascophlaera apis                     | CBS 402.96     | FJ358343          | FJ358275          | —                 |
| Ascophlaera apis                     | ATCC MYA-4451  | —                 | —                 | FJ172293          |
| Ascophlaera colubrina                | CBS 160.87     | FJ358344          | FJ358276          | U68320            |
| Ascophlaera duiformis                | ARSEF 5140     | —                 | HQ540518          | —                 |
| Ascophlaera subglobosa               | A.A. Wynns 5004 | —        | HQ540517          | —                 |
| Ascophlaera subglobosa               | DAOM 188973    | —                 | —                 | HQ540521          |
| Eremascus albic                       | CBS 975.69     | FJ358348          | FJ358283          | —                 |
| Arachniotus littoralis               | CBS 454.73     | FJ358340          | FJ358272          | —                 |
| Arachniotus ruber                    | UAMH 3543      | AY177296          | —                 | —                 |
| Gymnascella aurantiaca               | CBS 655.71     | AB015772          | AB040684          | —                 |
Table 1. (Continued).

| Genus and species            | Strain Number                                      | 18S       | 28S       | ITS       |
|------------------------------|-----------------------------------------------------|-----------|-----------|-----------|
| Gymnoascus confluens         | IMI 100873 = UAMH 3565                              | —         | —         | AJ315837  |
| Gymnoascus desertorum        | CBS 634.72                                          | —         | —         | AJ315838  |
| Gymnoascus petalosporus      | CBS 252.72 = UAMH 1712                              | AB015773  | AB040685  | —         |
| Gymnoascus reesii            | CBS 259.61                                          | FJ358349  | FJ368284  | —         |
| Kraurogyrnocarpa trocholeospa| CBS 591.71 = ATCC 18900 = UAMH 10101                | —         | AB075344  | KF477238  |
| Rollandina hyalinospora      | CBS 548.72 = UAMH 3155 = NRRL 2881                  | AB015775  | AB040687  | —         |
| Nannizzziopsis barbata       | UAMH 11185                                          | —         | —         | JF323871  |
| Nannizzziopsis hominis       | UAMH 7859                                           | —         | —         | KF477215  |
| Nannizzziopsis infrequens    | UAMH 10417                                          | —         | —         | AJ271434  |
| Nannizzziopsis obscura       | UAMH 5875                                           | KF466865  | —         | —         |
| Nannizzziopsis vriesii       | UAMH 3527                                           | —         | —         | KF477198  |
| Nannizzziopsis vriesii       | ATCC 22444 = UAMH 3713 = CBS 407.71 = IMI 149994    | AY304510  | AY176715  | —         |
| Paranannizzziopsis californiensis | UAMH 10693 = IMI 100873 = CBS 3565 = NRRL 2881 | —         | —         | KF466867  |
| Paranannizzziopsis crustacea | UAMH 10199                                          | —         | —         | KF466868  |
| Onygena equina               | TU101989                                            | —         | —         | UNITE-UDB018096 |
| "Paracoccidioides" sp.       | No name                                             | —         | —         | HQ413323  |
| Amaurascopsis perforata      | FMR 5489                                            | AJ315171  | —         | —         |
| Amaurascopsis reticulata     | IFO 9196                                            | —         | —         | AJ271434  |
| Amaurascopsis reticulata     | CBS 392.61                                          | —         | —         | AJ271418  |
| Amauroascus aureus           | ATCC 18654 = CBS 593.71 = NRRL 12,184 = UAMH 3157   | —         | —         | AY176705  |
| Amauroascus mutatus          | CBS 181.70                                          | —         | —         | AJ271567  |
| Amauroascus niger            | IFO 32599 = ATCC 22339 = UAMH 3544                  | —         | —         | AJ313434  |
| Aphanoascella galapagosensis | UAMH 11703                                          | —         | JQ864082  | JQ864081  |
| Aphanoascus arxii            | CBS 466.88                                          | —         | —         | AJ315843  |
| Aphanoascus foetidus         | CBS 452.75                                          | —         | —         | AJ439448  |
| Aphanoascus fulvescens       | NBRC 31723 = ATCC 36140 = IFO 31723                  | JN941600  | JN941548  | —         |
| Aphanoascus reticulisporus   | IMI 336466                                          | —         | —         | AJ439441  |
| Apinisia graminicola         | CBS 721.68                                          | AB015781  | AY176709  | —         |
| Apinisia racovitzae          | CBS 151.65                                          | —         | —         | AJ271429  |
| Arachnotheca glomerata       | CBS 348.71                                          | —         | AB075352  | —         |
| Ascocalvatia alevoleata      | ATCC 22147 = CBS 777.70 = UAMH 6475                  | —         | AY176710  | —         |
| Auxarthron reticulatum       | UAMH 2006                                           | —         | —         | AJ271568  |
| Auxarthron umbirinum         | UAMH 3952                                           | —         | —         | AJ177309  |
| Auxarthron zuffianum         | CBS 219.58                                          | —         | AY176712  | —         |
| Auxarthronopsis bandhavgarhensis | NFCCI 2185 = CBS 134524                             | JQ489393  | JQ489338  | HQ164436  |
| Bysssoygena ceratinophila    | ATCC 64724 = FMR 785                                 | AB075353  | —         | —         |
| Chlamydosauromyces punctatus | UAMH 9990                                           | —         | —         | AJ177297  |
| Chrysosporium parvum         | UAMH 1067                                           | U29390    | —         | —         |
| Coccidioides immitis         | ATCC 7366                                           | —         | AY176713  | —         |
| Coccidioides immitis         | CBS 166.51                                          | —         | —         | EF186783  |
| Coccidioides posadasii       | IFM 4935                                            | —         | —         | AB232883  |
| Emmonsia crescens            | UAMH 3008                                           | —         | —         | AF038334  |
| Emmonsia parva               | UAMH 130                                            | —         | —         | AF038333  |
| Emmonsia pasteuriana         | UAMH 9510                                           | —         | —         | EF592152  |
| Emmonsia sp.                 | UAMH 10539                                          | —         | —         | EF592156  |
| Emmonsia sp.                 | UAMH 7101                                           | —         | —         | EF592154  |
| Emmonsia sp.                 | FDBC2                                               | —         | —         | JQ247333  |
Table 1. (Continued).

| Genus and species | Strain Number | 18S | 28S | ITS |
|-------------------|---------------|-----|-----|-----|
| Kuehniella aurea  | CBS 593.71    |     |     |     |
| Lacazia loboii    |               |     |     |     |
| Malbranchea cinnamomea | CBS 960.72    |     |     |     |
| Malbranchea cinnamomea | CBS 343.55    |     |     |     |
| Malbranchea dendritica | UAMH 2731 = ATCC 34527 = CBS 131.77 = IMI 211199 = NCMH 367 |     |     |     |
| Malbranchea gypseae | IFM 47365     |     |     |     |
| Onygena equina    | ATCC 22731 = IFO 31785 = CBS 947.70 |     |     |     |
| Ophidiomyces ophiodicola | UAMH 6642      | KF466869 |     |     |
| Paracoccidioides brasiliensis | R-2878         |     |     |     |
| Paracoccidioides brasiliensis | Pb18           |     |     |     |
| Polyotolya hystricis | UAMH 7299     |     |     |     |
| Harorepupu aotearoa | PDD 105262     |     |     |     |
| Renispora flavissima | UAMH 4140 = ATCC 38503 | U293939 |     |     |
| Uncinocarpus queenslandicus | IFM 47370     |     |     |     |
| Uncinocarpus reessii | UAMH 160    | L27991 |     |     |
| Uncinocarpus reessii | ATCC 34533 = UAMH 3880 = CBS 121.77 |     |     |     |
| Uncinocarpus reessii | UAMH 3881 = ATCC 34534 = CBS 120.77 |     |     |     |
| Pseudospiromastix tentaculata | CBS 184.92 | AB075362 |     |     |
| Spiromastix asexualis | UTHSC DI-13-1 |     |     |     |
| Spiromastix princeps | IMI 169642 |     |     |     |
| Spiromastix warcupii | AFTOL-ID 430 | DQ782882 | DQ782909 | DQ782848 |
| Pyrgillus javanicus | AFTOL-ID 342 | DQ823110 | DQ823103 |     |
| Granulopyrenis seawardii | CBS 109025 = AFTOL-ID 2013 | EF411059 | EF411062 |     |
| Dermatocarpon luridum | AFTOL-ID 2277 | EF689833 | EF643750 |     |
| Placidiospora cinerascens | AFTOL-ID 2284 | EF689842 | EF643759 |     |
| Polystambia melaspora | AFTOL-ID 1356 | EF689854 | EF643770 |     |
| Geoglossum nigritum | AFTOL-ID 56 | AY544694 | AY544650 |     |
| Trichoglossum hirsutum | AFTOL-ID 64 | AY544697 | AY544653 |     |
| Cladonia caroliniana | AFTOL-ID 3 | AY584664 | AY584640 |     |
| Lecanora concolor | VR 2-IX-00/17 | AY640993 | AY640954 |     |
| Mitrella elegans | WZGeo47Clark | AY789334 | AY789335 |     |
| Pseudogymnoascus pannorum var. pannorum | CBS 108.14 | AB015785 | AB040703 |     |
| Thelebolus ellipoideus | AFTOL-ID 5005 | FJ176840 | FJ176895 |     |
| Myriodontium keratinophilum | DUMC 134.08 |     |     |     |
| Myriodontium keratinophilum | MEA-B4-D |     |     |     |
| Ascobolus crenulatus | AFTOL-ID 181 | AY544721 | AY544678 |     |
| Hypocrea americana | AFTOL-ID 52 | AY544693 | AY544649 |     |
| Chaetomium globosum | 15-5973 | AY545725 | AY545729 |     |
| Xylaria hypoxylon | spat03-03 | AY544692 | NG_027599 |     |

alignment of 876 base pairs in length that contained 456 (52 %) parsimony informative characters. *H. aotearoa* is sister to *Nannizzioiaceae* but lacking strong statistical support, where the sLRT branch support was only 0.74 in the ML analysis (data not shown) and the posterior probability is only 0.58 in the BI analysis (Fig. 3). All phylogenetic analyses show that *H. aotearoa* represents an isolated lineage within *Onygenales*.

**DISCUSSION**

Although *Harorepupu aotearoa* has never been grown on artificial media, we obtained DNA sequence data from dried specimens. Our comprehensive LSU and SSU phylogenetic tree show that this fungus is a member of *Onygenales* and that is distantly related from any recognized onygenalean fungi. In our ITS tree, *H. aotearoa* was sister to the *Nannizzioiaceae*
clade but with low support in the BI analysis. The family Nannizziosiaceae was described by Stchigel et al. (2013) on the basis of D1/D2 phylogenetic data, host range, morphology, and colony odour. Based on sexual morphology, historically taxonomically important for the group, species in Nannizziosiaceae differ from our fungus in having ascomata with peridial appendages and ascospores that appear smooth under the light microscope (Currah 1985). The future discovery of additional species of Harorepupu, and of any asexual morph, could help clarify its position within the order. For now, however, we prefer to treat it as incertae sedis within the order rather than introduce a new family name for this single genus.

The biology of Harorepupu aotearoa is not understood, but as all collections are on empty shells of members of the family Rhytididae, it may be restricted to this substrate. If this is the case, threats to the snail population will present a threat to the fungus population. At present, with increased...
predation and disturbance resulting in larger numbers of dead *Rhytididae* shells on the forest floor, this fungus may temporarily be more common than usual.

Members of the family *Rhytididae* are distributed across many regions linked geologically to Gondwana. Although *Harorepupu* is at present known only from New Zealand, additional material, and perhaps more species, may be expected on the shells of these snails in other regions.

![Fig. 3. 50% majority rule consensus tree from Bayesian inference analysis of ITS sequences. Posterior probabilities greater than 0.7 shown above the edges. Taxa labelled EX are represented by sequences from ex-type cultures; bold type indicates the type species of genera.](image-url)
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