TAXONOMIC STUDIES ON THE GENUS *RHIZOPOGON*, II. NOTES AND NEW RECORDS OF SPECIES FROM MEXICO AND CARIBBEAN COUNTRIES

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ESTUDIOS TAXONOMICOS EN EL GENERO *RHIZOPOGON*, II, NOTAS Y NUEVOS REGISTROS DE ESPECIES DE MEXICO Y DE LA ZONA DEL CARIBE

SUMMARY

Five species of *Rhizopogon*, all probably mycorrhizal associates of *Pinus* spp., are described in this paper. *Rhizopogon ochraceorubens, R. rubescens, R. subcaerulescens, R. nigrescens* and *R. superiorensis* var. *mexicanus*, this latter described as new taxa, are recorded from central or southern Mexico. The first three are common in northwestern United States, while *R. superiorensis* var. *superiorensis* has been recorded from northern Michigan and Japan. The distribution for *R. nigrescens*, previously reported from southeastern United States, is extended to the Bahamas, Belize, Honduras, Nicaragua, and Puerto Rico.

RESUMEN

Se describen cinco especies de *Rhizopogon* de México y de la región del Caribe, todas ellas probablemente asociadas micorrícicamente con *Pinus* spp. Las especies consideradas son *Rhizopogon ochraceorubens, R. rubescens, R. subcaerulescens, R. nigrescens* y *R. superiorensis* var. *mexicanus*, este último taxa descrito como nuevo. Las primeras tres especies son comunes en el Noroeste de E. U. A., mientras que *R. superiorensis* var. *superiorensis* solo se conocía de Michigan y del Japón. *R. nigrescens* solo se conocía del Sureste de E. U. A. y ahora se extiende su distribución hasta Bahamas, Belice, Honduras, Nicaragua y Puerto Rico.

INTRODUCTION

Trappe and Guzmán (1971) described *Rhizopogon ochraceorubens, R. subba-*

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dius and *R. michoacanicus*, from Mexico. Since then, 51 additonal *Rhizopogon* collections from Mexico and Caribbean countries have been unearthed by J. Trappe, M. Ivory, and G. Guzmán. *R. ochraceorubens, R. rubescens, R. subcaerulescens,* and *R. superiorensis* var. *mexicanus* were collected in the central highlands of Mexico. This is the first report of *R. rubescens* and *R. subcaerulescens* in Mexico; they are also common to northwestern United States. Typical *R. superiorensis* is known from A. H. Smith's type from northern Michigan and from Japan (Trappe, unpublished data). *R. nigrescens*, previously reported from southeastern United States under *Pinus* spp., was collected by Ivory in Andros and Grand Bahama Islands of the Bahamas, Belize, Honduras, Nicaragua, and Puerto Rico in stands of *Pinus caribaea* or *P. oocarpa.*

The occurrence in Mexico of *Rhizopogon* spp. also common to the northern United States fits comfortably with other similarities of mycofloras as established by Guzmán (1973) and Welden and Lemke (1961). Data on the genus *Rhizopogon* in Mexico are still preliminary, because specimens have been collected only over short periods and from relatively few habitats. Collection over a longer period and a broader array of habitats will produce more species.

The primary references used for species identification were Smith and Zeller (1966), Smith (1966), Hosford (1972) and Coker and Couch (1928). All species were compared with types. Fresh descriptions were prepared from Trappe's field notes for Mexican collections and Ivory's for collections of *R. nigrescens*. Colors refer to Kelly and Judd (1965) ISCC-NBS names, unless indicated otherwise, and were compared when possible with the ISCC-NBS centroid-color set (Kelly, 1965). Reagents used for macroscopic chemical reactions of peridia were 3% KOH and 10% $FeSO_4$. All microscopic color notes and descriptions were made from sections reimbibed in 3% KOH or Melzer's solution. Cited collections are deposited at Oregon State University (OSC), Escuela Nacional de Ciencias Biológicas (ENCB), and Central Washington University (CWU).

Dichotomous and synoptic keys are provided for the species described in this paper as well as by Trappe and Guzmán (1971). Users of the keys should be aware that many additional species of *Rhizopogon* will surely be found in Mexico and the Caribbean countries. Collections that do not key out or that do not fit the descriptions are likely to be new records or new taxa. We would be interested to examine any collections for which detailed notes on fresh characters are recorded.

DICHOTOMOUS KEY TO SPECIES

1. Spores 8-12 x 3.5-6 μm. 2
1. Spores 5.5-8 x 2-3.5 μm 4
   2. Spores distinctly truncate-cupped as seen with high-dry microscope objective. . . . . .*R. michoacanicus*
   2. Spores not truncate-cupped. 3
3. Spores 7.4-10.8 x 2.3-3.4 μm, averaging 8.8 x 2.8 μm. . . . . .*R. subcaerulescens*
3. Spores 9-12(-14) x 3.5-4.5(-5) μm, averaging 10 x 3.8 μm . . . . . .*R. subbadius*
   4. Spores distinctly truncate-cupped as seen with high-dry microscope objective; glebal chambers minute, more or less filled with a sticky fluid in fresh specimens . . . . . .*R. superiorensis var. mexicanus*

4. Spores not truncate-cupped; glebal chambers visible to naked eye, not filled with sticky fluid when fresh 5
5. Fresh peridium white to brownish, lacking any distinct yellow coloration, not brusing when injured, drying an even dark brown; spores 7.4-10.8 x 2.3-3.4 μm, averaging 8.8 x 2.8 μm . . . . . *R. subcaerulescens*
5. Not with the above combination of features 6
6. Spores 2.8-4 μm wide, averaging 3.2 μm. . . . . *R. rubescens*
6. Spores 2-3 μm wide, averaging 2.3-2.5 μm 7
7. Fresh peridium bright yellow, drying dark reddish brown, covered with a crowded network of yellow to reddish brown rhizomorphs . . . . . *R. ochraceorubens*
7. Fresh peridium pale yellow to yellow, drying yellowish brown to dark reddish brown or black; rhizomorphs scattered on surface, not forming a dense network. . . . . *R. nigrescens*

SYNOPTIC KEY TO SPECIES

Synoptic keys provide a convenient alternative to dichotomous keys for species determination and are additionally useful to summarize the more important diagnostic features of taxa. Korf (1972) provides detailed instructions on use of synoptic keys. In brief, select a feature that is either convenient to observe or seems distinctive. Write all the species numbers listed for the appropriate choice of that feature on a separate piece of paper. Then select a second feature and draw a line through any numbers written down from the first feature that are not listed in the appropriate choice of the second feature. Continue with additional selected features until only one number remains. That number represents either a species included in this or Trappe and Guzmán's (1971) paper or a related species not yet recorded from the area of consideration. The species are numbered as follows:

1 = *R. subcaerulescens*
2 = *R. subbadius*
3 = *R. superiorensis* var. *mexicanus*
4 = *R. michoacanicus*
5 = *R. rubescens*
6 = *R. nigrescens*
7 = *R. ochraceorubens*

I Macroscopic Features

A. Basic color of fresh, mature peridium

1. *Pale to bright yellow*	2,3,5,6,7
2. *Pale brown to brown*	1
3. *White*	all species in youth
4. *Not recorded*	4

B. Color reaction of fresh peridium within 5 minutes after brusing or cutting

1. *Pink, red, orange or brown*	5,6

2. *No color reaction* 1, 2, 3, 7
3. *Not recorded* 4

C. Color reaction with KOH application to fresh peridium

1. *Pink, red, dark reddish brown (no olive)* 3, 5, 6
2. *Olivaceous, bluish green, to near black (sometimes with transitory red color)* 1, 2, 7
3. *Reaction negative or weakly orange yellow, orange, to dull brown.* 7
4. *Not recorded* 4

D. Rhizomorphs

1. *Absent or scanty and not forming a conspicuous network.* 4, 5, 6
2. *Abundant, yellow, orange brown to reddish brown, coarse textured* 3, 6, 7
3. *Abundant, white or brown, minute* 1, 2

E. Color and special marking of dried peridium

1. *Color*

a. *light brown to dark brown* 1, 2, 4, 6
b. *reddish to dark reddish brown overall* 3, 7
c. *dingy yellow or yellow with reddish to dark brown or blackish areas* 5
d. *black, often shiny* 6

2. *Special markings*

a. *speckled with small, round, pallid to yellowish spots* 4, 6
b. *not speckled* 1, 2, 3, 5, 6, 7

F. Fresh gleba

1. *Olive to olive brown to brownish black with yellowish marbling and sticky fluid* 3
2. *White to some shade of olive or brown without yellowish marbling or fluid* 1, 2, 4, 5, 6, 7

G. Size of Gasterocarp

1. *Most less than 1 cm diameter, often 0.5 cm* 3
2. *Most greater than 1 cm diameter, often 2-4 cm* 1, 2, 4, 5, 6, 7

II Microscopic Features

A. Spores

1. *Size range*

a. *8-12 x 3.5-6 µm*	1,2,4
b. *5.5-8 x 2-3.5 µm*	3,5,6,7

2. *Average width*

a. *3 µm or greater*	1,2,3,4,5
b. *Less than 3 µm*	1,6,7

3. *Shape*

a. *regular*	5,6,7
b. *irregular*	1,2,3,4,5

4. *Basal truncation or cup as seen under high dry*

a. *present*	3,4
b. *absent*	1,2,5,6,7

B. Subhymeniun

a. *isodiametric cells*	1,4,5,6,7
b. *narrow hyphae*	1,2,3

C. Peridium

1. *Hyphal diameter*

a. *mostly >6 µm*	3,4,5,6,7
b. *mostly <6 µm*	1,2,6

2. *Pigment deposits as reimbibed in KOH*

a. *mostly reddish orange to purplish red*	3,4,6,7
b. *mostly some shade of olive or brown*	1,2,4,5,6

SPECIES STUDIED

Rhizopogon ochraceorubens Smith in Smith & Zeller,
Mem. New York Bot. Gard. 14: 124-125. 1966.

Gasterocarps 1-3 cm in diameter, subglobose to flattened or furrowed. Fresh peridium thin, white in youth, soon becoming yellow to bright yellow, not staining from injury or exposure; subcutis white to pallid or dull yellow, unchanging when cut. Rhizomorphs at first yellow, becoming orange to orange brown, forming a conspicuous, appressed, reticulum with free rhizomorphs often prominent at base. Dried peridium moderate red-15, grayish red-19 (= vinaceous red), moderate reddish brown-43 (= vinaceous brown) to deep reddish brown-41 (= dark brown in overly mature specimens), with rhizomorphs inconspicuous and concolorous with peridium. Chemical reactions: KOH on fresh peridium slowly orange yellow on white specimens, and olivaceous, orange to dull brown on older, colored specimens (the reaction generally weak); $FeSO_4$ slowly olivaceous.

Fresh gleba white to pale grayish yellow in youth, becoming distinctly olive to olive brown at maturity, firm to spongy, with small but visible chambers, as dried deep yellow brown-75 or lighter and somewhat friable but easily sectioned.

Spores (5.1-)5.7-8 x 2-2.5 μm, averaging 6.8 x 2.3 μm, cylindrical to ovate, basal truncation incospicuous except under oil inmersion or as seen from basal view, in KOH hyaline singly and dingy yellow in masses, in Melzer's solution pale yellow singly and bright yellow in masses; no false septum evident.

Basidia cylindric or tapering toward the apex, thin-walled and collapsing at maturity, 4-6 spored. Brachybasidioles clavate, walls thin in youth but soon thickening to 1-2 μm, central cytoplasm not staining in KOH. Trama of narrow, hyaline hyphae that become hyghly gelatinized and refractive in KOH; some oleiferous hyphae evident in Melzer's solution. Subhymenium gelatinized in old specimens, in younger specimens cellular, 1 to 3 cells deep, as combined with the hymenial elements giving a regular columnar appearance to tramal margins. Peridium of appressed interwoven hyphae mostly 3-6 μm in diameter and rhizomorphs; as reimbibed in KOH, deposits of deep reddish orange-36 to light grayish purplish red-261 or deep purplish red-256 pigment within and along hyphal margin; rhizomorphs at the surface grayish purplish red-262 or deep redish orange-36; no sphaerocysts present, but rhizomorphs in cross section appearing as large pockets of isodiametric cells. Al tissues inamyloid. Clamp connections not observed.

Habitat and Mycorrhizal Hosts: Hypogeous under *Pinus* spp. *Trappe 3432* was associated with *Pinus hartwegii* and *3420* under an unidentified 5 needle pine with small cones.

Material Examined: MEXICO-MICHOACAN: *Trappe 3421, 3423*, 23 Aug. 1972, 10 km North of Uruapan, carretera Uruapan-Paracho, elevation 1700 m; *Trappe 3420*, 22 Aug. 1972, near Pueblo Viejo, carretera Ciudad Hidalgo-Morelia. MORELOS: *Trappe 3477*, 12 Sept. 1972, 5 km North of Cuernavaca, carretera vieja Cuernavaca-México. STATE OF MEXICO: *Trappe 3432*, 28 Aug. 1972; *Herrera 6796* (MEXU), 3 Oct. 1965, Volcán Popocatépetl, Tlamacas, elevation 3800 m.

R. ochraceorubens is a large, yellow species densely netted by overlying rhizomorphs and is easily distinguished from the others in this paper by this combination of features: (1) peridium deep yellow when fresh, completely red to deep reddish brown when dried, (2) fresh peridium not discoloring where bruised or cut, (3) conspicuous network of rhizomorphs concolorous to reddish-brown when fresh but when dried red to dark brown and often inconspicuous (blending with peridium), and (4) spores less than 3 μm wide.

As in the Western U.S. and Canada, this species is associated with *Pinus* spp. Michoacán collections were more brown than red as dried compared to the others examined. This seems to be related to the age of the specimen: the more mature the specimen, the less red as dried. In all other characters the collections were compatible.

Rhizopogon superiorensis resembles *R. ochraceorubens* both in fresh and dried peridial color and rhizomorphs but is easily distinguished by spore characteristics and size of gasterocarps. *R. occidentalis*, common in the Western U. S. but not yet reported from Mexico, has similar spores and fresh colors. It is readily distinguished from *R. ochraceorubens* by its overall yellow coloration as dried and lack of reddish to purple pigment deposits in KOH mounts of the peridium.

Rhizopogon rubescens (Tul. & Tul.) Tul. & Tul.
Giorn. Bot. Ital. 2:58. 1844.

Gasfrocarps 1-3 cm in diameter, ± subglobose. Fresh peridium felty fibrillose, white in youth, becoming yellow to near olive yellow or yellow ochre at maturity (particularly where exposed), surface fibrils slowly staining red to brown with injury or exposure; subcutis pallid, quickly staining pink, red or reddish brown when cut. Rhizomorphs emergent at base but otherwise scanty or lacking. Dried peridium dingy yellow with buised and reddish to dark brown stained areas. Chemical reactions: KOH on fresh surface pink to reddish brown, $FeSO_4$ slowly olive (sometimes faint).

Fresh gleba pallid in youth, becoming olivaceous with age and finally developing moderate brown-53 (=cinnamon brown) areas, firm, with large and clearly visible chambers by maturity. Dried peridium pale yellow to deep yellowish brown-75 or moderate to deep brown-56, 58, somewhat crumbly. Odor not distinctive.

Spores (6.3-)6.8-9(-10) x (2.3-)2.8-3.7(-4) μm, averaging 7.5 x 3.2 μm, subfusoid to ovoid, basal scar sometimes evident under high dry microscope objetive but not conspicuous, yellow in masses in both KOH and Melzer's solution, 1 or 2 hyaline guttules present.

Basidia subcylindric, ventricose to clavate, 13-25 x 4.6 μm, hyaline in KOH, 6-8 spored, thin-walled and collapsing at maturity. Brachybasidioles ovate, obovoid, clavate, subcylindric or versiform, 13-26 x 9.5-14 μm, the walls thin but soon gelatinous thickened to 2-5 μm, with colorless, amorphous contents in KOH, readily disarticulating and floating free in crushed mounts. Trama highly gelatinized and refractive in both young and mature specimens. Subhymenium poorly developed, cellular, becoming gelatinized as the brachybasidioles. Peridium appearing ± 2-layered from layering of pigments when reimbibed in KOH; epicutis of appressed interwoven hyphae mostly 7-10 μm wide but with scattered, swollen hyphae, thin-walled, occasionally with flagellate end cells, hyaline to pale yellow as reimbibed in KOH, lacking copious pigment deposits; subcutis with copious reddish brown to yellowish brown intercellular pigment as reimbibed in KOH, some scattered inflated cells present; orange-brown pigment globules numerous in Melzer's solution. All tissues inamyloid. Clamp connections not observed.

Habitat and Mycorrhizal Hosts: Hypogeous to subhypogeous in humus under mixed stands of *Pinus-Quercus* and *Arbutus-Pinus-Quercus*.

Material Examined: MEXICO-CHIAPAS: *Trappe 3325, 3334*, 14 and 16 July 1972, carretera Tuxtla Gutierrez-San Cristóbal; *Trappe 3329*, 14 July 1972, Lagunas de Montebello National Park, elevation 1550 m. STATE OF MEXICO: *Guzmán 3982*, 29 June 1963, San Cayetano, 20 km N of Valle de Bravo, Estación Cinegética S. A.G.

R. rubescens may be distinguished by this combination of features: (1) peridium pale yellow to yellow and developing reddish brown stains, when fresh, dingy yellow with reddish to dark brown or black areas when dried, (2) subcutis quickly becoming pink to reddish brown where bruised or cut (surface of peridium often not reacting), (3) KOH producing a pink to reddish brown reaction on fresh peridium; $FeSO_4$ reaction slowly olivaceous on fresh peridium, (4) few rhizomorphs present over surface, (5) spores averaging more than 3 μm wide, subfusoid to ovoid,

and (6) thick-walled, gelatinized, brachybasidioles, which disarticulate from the hymenial layer in crush mounts of mature specimens.

As in many *Rhizopogon* spp., the brachybasidioles become thickwalled at maturity. However, the degree of wall thickening, up to 5 μm in *R. rubescens*, makes this a disgnostically important feature. The gleba of young specimens with thin-walled brachybasidioles is generally pale yellow, that of mature specimens is olive yellow to cinnamon brown. Two similar yellow species, *R. luteolus* and *R. vulgaris*, may be confused with *R. rubescens*. *R. luteolus*, with similar spores, is distinguished by lack of red pigments and red bruising reaction in the peridium, minute glebal chambers often filled with spores, and bone-hard to almost glassy gleba as dried. *R. vulgaris* bruises red as *R. rubescens* but has spores averaging less than 2.5 μm wide and a peridium that dries yellow to brown.

Rhizopogon subcaerulescens Smith in Smith & Zeller
Mem. New York Bot. Gard. 14:48. 1966

Gasterocarps 1-2.5(-3.5) cm in diameter, subglobose to irregular. Fresh peridium 0.5-1 mm thick, white, not discoloring where bruised or cut, overlain with minute white to brown fibrils, developing reddish brown to brown stains with age or prolonged exposure. Rhizomorphs fine, white becoming brown, scattered and appressed overall, often forming a tangled basal cluster. Dried peridium dark brown. Chemical reactions: KOH on fresh peridium quickly olive to olive green or bluish green, (often with localizaed red tones, specially in young gasterocarps or in the subcutis) soon becoming bluish black; $FeSO_4$ olivaceous to grayish green.

Fresh gleba white and soft in youth, becoming yellowish brown to olivaceous or dark brown with age, firm-cartilaginous with very minute chambers that are nearly filled with spores near the peridium, as dried somewhat lighter in color and hard. Odor none or slightly fruity.

Spores 7.4-10.8 x 2.3-3.4 μm, averaging 8.8 x 2.8 μm, oblong to elliptical in dorsal-ventril view, slightly boletoid in leteral view or some fusiform to irregularly shaped, basal cup usually incospicuous, evident on some under oil inmersion; young spores reimbibing poorly, thin-walled, collapsing, older spores reimbibing more fully, walls rigid, slightly thickened, not collapsing, usually with at least one large guttule that nearly fills the entire spore; young spores faintly amyloid, grayish yellow green-122, grayish olive green-127 to grayish green-150; older spores, not distinctly amyloid, but strong yellowish brown-74 to light or moderate olive brown-94-5 with a smoky cast in masses.

Basidia 15-25 x 3-5 μm, clavate to subcylindric, not protruding, thin-walled and collapsing after spore production, hyaline. Brachybasidioles 10-15 x 4-8 μ, thin-walled, not gelatinizing, subylindric to clavate, hyaline. Trama of ilamentous hyphae which soon become gelatinized and higly refractive in KOH. Subhymenium of branching, often cellular hyphae 5-10 μm in diameter, at maturity gelatinous-refractive in KOH. Peridium of appressed hyphae 5-13 μm in diameter, hyaline, with gelatinized walls 1-2.5 μm thick, in places with many rounded cells up to 30 μm in diameter (mostly cross sections of embedded rhizomorphs); as reimbibed in KOH, strong yellowish brown-74, to deep brown-56 pigments present, often encrusting the hyphae, with occasional localized areas of olive to olive gree; large strong

reddish brown-40 pigment globules present in Melzer's solution. All tissues inamyloid. Oleiferous hyphae present. Clamp connections not observed.

Habitat and Mycorrhizal Hosts: Hypogeous under *Pinus* spp., or mixed stands of *Pinus-Abies* or *Pinus-Quercus. Trappe 3395, 3433, 3435* were associated with *Pinus hartwegii* & *Trappe 3444* with *Abies religiosa.*

Material Examined: MEXICO-CHIAPAS: *Trappe 3335*, 15 July 1972, carretera Tuxtla Gutiérrez-San Cristóbal. STATE OF MEXICO: *Trappe 3398*, 14 Aug. 1972, camino Amecameca-Tlamacas, Volcán Popocatépetl, elev. 3500 m; *Trappe 3414* (leg. J.W. Gedemann 3315), 18 Aug. 1972, camino Nevado de Toluca near timberline, elev. 3500 m; *Trappe 3439, 3441, 3442, 3443, 3444*, 30 Aug. 1972, Parque Nacional Nevado de Toluca, 5 km SW of La Puerta, carretera Toluca-Temascaltepec. MICHOACAN: *Trappe 3422*, 28 Aug. 1972, 10 km N of Uruapan along carretera Uruapan-Paracho, elev. 1700 m. MORELOS: *Trappe 3380*, 10 Aug. 1972, NE of Cuernavaca, near big hairpin curve on autopista México-Cuernavaca, *Trappe 3471, 3472*, 12 Sept. 1972, Parque Nacional Lagunas de Zempoala. PUEBLA: *Trappe 3395*, 14 Aug. 1972, Paso de Cortés, elev. 3750; *Trappe 3433*, 28 Aug. 1972, Tlamacas (Volcán Popocatépetl) elev. 3800 m; *Trappe 3435*, Aug. 28, 1972, camino Amecameca-Tlamacas (Volcán Popocatépetl) elev. 3500 m.

R. subcaerulescens is a variable species. The most dependable characters for identifying are: (1) gasterocarps firm, dry, coarsely fibrillose (rough textured), with a conspicuous overlay of loosely attached, fine white rhizomorphs, (2) peridium thick, white, often developing reddish brown tones that tend to darken in age to brown and dark brown as dried but not discoloring where bruised or cut, (3) KOH reaction of fresh peridium quickly olive green or bluish green to blackish (often with a reddish transitoty stage), and (4) Fe SO_4 reaction of fresh peridium distinctly olive to olive green.

Important microscopic features include weakly amyllid spores averaging 8.8 x 2.8 μm, gelatinization of hyphae in peridium and trama, and thin-walled hymenial elements. However, these microscopic features vary. Spore amyloidity, but is difficult to detect in all but young specimens. The reaction is not dark blue or blackish but rather a grayish olive as seen in mases. Older spores lack even this, but may have a "smoky" cast as seen in masses along the hymenium. Spore size is fairly consistent within the range provided, but spore shape may vafy a good deal. Triangular, allantoid, subpyriform and mitten-shaped spores may be observed in one specimen and none int he next. Gelatinization of the glebal trama may be observed in dried specimens with a hand lens: the smoothly cut surface appearse glassy.

R. subbadius, reported from Mexico by Trappe and Guzmán (1971), is closely related. It is easily distinguished by its much larger spores, 9-12(-14) x 3.5-4.5 (-5) μm.

Rhizopogon superiorensis Smith, *The Michigan Botanist 5*: 20. 1966.
var. *mexicanus* var. nov.

Gasterocarpia 0.3-1.5 cm crassa, globosa vel subglobosa, alutacea vel lutea, fibrillis croceis adpressis. Gleba ad maturitatum olivacea, venis sterilibus erratice marmorata interdum latice viscidi. Sporae (6.2-)6.8-8(-8.5) x (2.3-)2.8-3.4(4.0) μm in medio 7.2x3.1 μm, anguste ellipsoideae, ovoideae, vel interdum subangulares vel irregulares, basi truncato-cupulati. Holotypus Trappe 3320 (OSC; isotypus ENCB, CWU).

Gasterocarps 0.3-1.5(-3) cm in diameter, globose to subglobose or slightly irregular. Fresh peridium pale yellow to bright yellow overlain with appressed, fine, orange brown fibrils, not staining from injury or exposure, rhizomorphs appressed overall but most conspicuous at base. Dried peridium grayish reddish brown-46 to dark grayish reddish brown-47 or moderate to dark reddish brown-43-4 (=Bay or Marroon), with rhizomorphs inconspicuous and concolorous with peridium. Chemical reactions: KOH on fresh peridium quickly dark reddish brown, $FeSO_4$ olive, soon black.

Fresh gleba olive in youth, becoming olive brown to brownish black at maturity, erratically marbled with veins of sterile tissue, firm with minute chamers nearly filled spores and often exuding a sticky fluid, as dried yellowish brown to dark yellowish brown-78 with pallid veins, very hard, the sectioned surface glassy.

Spores (6.2-) 6.8-8 (-8.5) x (2.3-) 2.8-3.4 (-4.0) μm averaging 7.2 x 3.1 μm, mostly narrowly ellipsoid to ovoid but some subangular or irregular, the base with a distinct cup formed by sterigmal walls, most with one large guttule, hayline singly and dark yellow brown in masses in KOH and Melzer's solution.

Basidia 6-8 spored, clavate to subcylindric, up to 5 μm broad, obscured by masses of spores, thin-walled and collapsing at maturity. Brachybasidioles clavate, thin-walled, often with hyaline guttules as seen in KOH. Trama broad, of narrow, hyaline, interwoven hyphae 1.7-2.6 (-5) μm broad, gelatinous refractive in KOH. Subhymenium gelatinous-refractive in KOH, filamentous and poorly delimited from central trama. Peridium thick, of interwoven hyphae mostly 3-6 μm broad, with numerous small pockets of rounded cells representing cross sections of rhizomorphs imbedded in the peridial matrix; as reimbibed in KOH, copious deposits of strong reddish brown-40 to grayish red-19 (= dark vinaceous drab) or grayish purplish red-259 pigment between and along hyphae and hyphal walls somewhat gelatinized, hyaline and refractive; in Melzer's solution, large reddish brown pigment globules and versiorm bodies forming, no amyloid granules or hyphae observed. Clamp connections not observed.

Habitat and Mycorrhizal Hosts: Hypogeous in mixed forest of *Pinus-Arbutus*. Collection T3331 occurred under *Quercus* with no other potential hosts present.

Material Examined: MEXICO. CHIAPAS: *Trappe 3327, 3331*, July 14 & 15, 1972, Lagunas de Monte Bello National Park, elev. 1500 m; *Trappe 3324* (holotype), July 14, 1972, carretera Tuxtla Gutiérrez-San Cristóbal.

R. superiorensis var. *mexicanus* is readily recognizable by its combination of: (1) peridium yellow fresh, dark reddish brown dried, (2) moist or sticky, olive gleba with pallid to yellowish veins, and (3) spores with a distinct basal cup or truncation.

The gasterocarps usually possess a distinct network of superficial rhizomorphs and are small and nearly globose in shape. Reimbibed specimens reveal gelatinous-refractive hyphae throughout, minute spore-filled glebal chambers, and abundant reddish brown pigments in the peridial layer. Dried specimens superficially resemble small *R. ochraceorubens* but are easily distinguished from that species by spore and glebal characteristics.

This is the first report of *R. superiorensis* outside of northern Michigan, although we recently identified collections of var. *superiorensis* from Japan (unpublished). *R. superiorensis* var. *mexicanus* has spores 6-8 μm long, whereas those of var. *superiorensis* are typically 9-11 μm. Otherwise, the two varieties do not differ markedly.

Rhizzopogon nigrescens Coker & Couch, *Gasteromycetes of Eastern U.S. and Canada*, p. 30, 1928.

Gasterocarps 1-4.5 cm in diameter, irregular to subglobose. Fresh peridium smooth, thin, specimens white in youth, later becoming pale yellowith pinkish tinge, by maturity yellow or straw and in exposed or bruised areas mottled strong yellowish brown-74 (=hazel), yellowish orange (=safron), or reddish brown, bruising orange yellow to reddish brown (pinkish bruising reaction suspected in white to pale yellow specimens based on S/138). Thizomorphs appressed, scattered above, more conspicuous below, and emanating from base, dark brown to reddish brown at maturity. Dried somewhat sticky to subviscid when rewetted, black, dark reddish brown-44, or light yellowish brown-76 in older specimens, occasionally with small pale yellow spots where flaked away to expose the underlying gleba, with rhizomorphs dark reddish brown-44 or black and often incospicuous. Chemical reactions: KOH on fresh peridium quickly bright red, dark red (= bay red) to dark brown finally black in all cases noted, $FeSO_4$ recorded as negative.

Fresh gleba white to olivaceous, firm-cartilaginous with chambers small but visible, as dried hard but sectioning well, pale yellow-89 (= light buff), moderate yellowish brown-77 to deep yellowish brown-75.

Spores (5-) 6-7 (-8) x (1.8-) 2-3 (-3.4) μm, averaging 6.2 x 2.5 μm, oblong to subellipsoid, obscurely truncate, biguttulate or pseudoseptate when mature, thin walled, in KOH faintly yellow to hyaline singly as seen, and pale yellow to olive brown in masses, in Melzer's solution yellow singly, yellow to pale olive brown-94 to strong yellow brown-74 in masses.

Basidia 6, 7 and 8 spored, 16-25 x 5-6 μm, thin walled and soon collapsing often with spores still attached. Brachybasidioles 7-10 μm wide, in youth thin walled, by maturity thick walled with only a small central cavity containing amorphous material which does not stain in Melzer's solution. Trama of highly refractive, gelatinized hyphae, some diverging from central strand to produce a ± cellular, nongelatinized sybhymenium. Peridium of interwoven hyphae 4-10 μm in diameter, as reimbibed in KOH obscured by masses of brown to olive brown, moderate reddish brown-43 (= mahogany) or vinaceous pigment, in Melzer's solution vivid reddish orange-38 or reddish brown-40 globules and amorphous pigment present, appresed and imbedded rhizomorphs observed in tangential and cross section. All tissues inamyloid. No clamp connections observed.

Habitat and Mycorrhizal Hosts: Bahamas: hypogeous under litter in stands of *Pinus caribaea* var. *bahamensis* on rocky, thin, alkaline, coral limestone soil. Belize: hypogeous under litter in stands of *P. caribaea* with dense understory of herbs and shrubs. Nicaragua: in plantations of *P. caribaea*. Honduras: hypogeous of erumpant in open, mixed stands of *P. caribaea* and *P. oocarpa*, on dry rocky hills prone to fire or in open stands of *P. oocarpa*. Puerto Rico: in single row of *Pinus* spp. at edge of former nursery, inoculated soil imported from eastern U.S.

Material Examined (All specimens, unless otherwise indicated, collected by M.H. Ivory): BAHAMAS. *Andros Island: S/162,* 25 Nov.. 1976; *S/146*, 26 Nov. 1976; *S/425*, 27 Nov. 1976. Grand Bahama Island: *S/430*, 29 Nov. 1976. All collections isolated in culture. BELIZE. Melinda F.S., elev. 10 m: *S/138, 139,* 22 June 1976; *S/337, 342*, 1-2 Nov. 1976; *S/364, 365*, 7 Nov. 1976. Silver Creek F.S., elev. 10-30

m: *S/152*, 22 June 1976: *S/308*, 25 Oct. 1976. Augustine F.S., elev. 500 m: *S/312*, 27 Oct. 1976; *S/352*, 4 Nov. 1976. NICARAGUA. Puerto Cabezas, garden of the INFONAC elev. 5 m: *S/372*, 16 Nov. 1976. HONDURAS. Los Limones, elev. 650 m: *C/7*, 16 July 1976, *S/230*, 7 Oct. 1976; *S/268, 283*, 14 Oct. 1976, Siguatepeque, elev. 1080 m: *S/220*, 10 Oct. 1976; *S/247*, 12 Oct. 1976. PUERTO RICO. Catalina nursery: *S/398*, 21 Nov. 1976.

Discussion: *Rhizopogon nigrescens* is distinguished by: (1) young peridium white to pale yellow, at naturity mottled with yellowish orange and reddish brown (rusty brown), shiny or dull black to sordid brown as dried, (2) fresh peridium bruising or staining yellowish orange or reddish brown, (3) conspicuous rhizomorphs fresh often becoming inconspicuous when dried, (4) deep red to reddish brown KOH reaction of fresh peridium, and (5) spores less than 3 μm wide.

We did not observe a dark olive $FeSO_4$ reaction in the reimbibed peridium as mentioned in Smith & Zeller (1966). A viscid peridium as described by Coker & Couch (1928) was not recorded in fresh material, which was rather recorded as dry and smooth. This feature, however, would vary with soil moisture at time of collection. In specimens dried shiny black, wetting and rubbing did produce a somewhat sticky surface. Smith (Smith and Zeller 1966) emphasizes the subviscid condition as a key character for *R. nigrescens*.

Ivory S342 from Belize is included here even tohough isolates from that collection differ markedly from others he obtained (Ivory, personal communication). Our examination of the dries material revealed slightly wider spores (averaging 2.9 μm wide) and bone-hard gleba. We presently considere these differences as minor but a future study of the culture and additional collections might show otherwise.

The Bahama collections are tentatively assigned to this species, even though the red bruising reaction recorded and spore size are similar to *R. rubescens* and *R. roseolus*. A decision is difficult, because some of the collections are preserved in FAA, the others are too thinly sliced to accurately determine the color pattern as dried, and field notes are scanty. A composite description is provived below from the notes of Ivory:

R. nigrescens (Bahama collections)

Gasterocarps scattered to solitary, (0.5-) 1-5 cm in diameter, subglobose, connected to soil by single or clustered thin, white rhizomorphs. Fresh peridium smooth, soft, moist to dry, white when young, becoming pale buff to buff or vinaceous buff in age, bruising red or vinaceous (especially when young). Dried peridium blackish with areas of moderate reddish brown-43 in thinly sliced specimens; young specimens preserved in FAA are light yellowish pink-28, mature specimens dark to deep reddish brown-44, 41; appressed rhizomorphs inconspicuous in both pickled and dried material.

Chemical reactions: NH_3 and Melzer's solution negative on the surface and flesh, $FeSO_4$ crystals rubbed on surface of young and old specimens soon greenish-black. Fresh gleba tough-spongy and pale buff to hazel or straw. Slightly musty odor recorded.

Spores (6-) 6.5-7 (-8) x (2.5-) 2.8-3 (-3.4) μm, averaging 6.5 x 2.8 μm. In all other microscopic features no significant differences from to other *R. nigrescens* collections were noted.

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