MYCOTAXON

Vol. VI, No. 2, pp. 359-366 October-December 1977

THREE NEW ENDOGONACEAE: *GLOMUS CONSTRICTUS*, *SCLEROCYSTIS CLAVISPORA*, AND *ACAULOSPORA SCROBICULATA*

by

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In the course of collecting hypogeous fungi in Mexico, I sampled soils for Endogonaceae by the wet-sieving and decanting method (Gerdemann and Nicolson 1963). The three species described here were among the many found. Drs. G. Zentmyer and J. Menge of the University of California at Riverside subsequently found one of them, *Glomus constrictus*, in southern California orchards and provided specimens for examination. I then found another, *Acaulospora scrobiculata*, in the United States and Japan. Collections are deposited in the herbaria of Oregon State University (OSC), the Farlow Herbarium (FH), and Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional (ENCB).

SCLEROCYSTIS CLAVISPORA Trappe sp. nov. Fig. 1

Sporocarpia globosa vel subglobosa, 460-750 x 590-780 µm, fusca vel atra, minute verrucosa, e strato chlamydosporarum uno medullam e hyphis intertextam obducente constantia; peridium destitutum. Chlamydosporae brunneae, 140-185 x (20-) 25-40 (-50) µm, clavatae vel subcylindricae, parietibus lateralibus 1.5-5 µm, parietibus apicalibus 17-25 µm, parietibus basalibus 5-8 µm. TYPUS: Mexico, Veracruz, Trappe 3568 (OSC).

Sporocarps globose to subglobose, 460-750 x 590-780 µm, brownish black to black, minutely verrucose from exposed tips of spores formed radially in a single, tightly packed layer

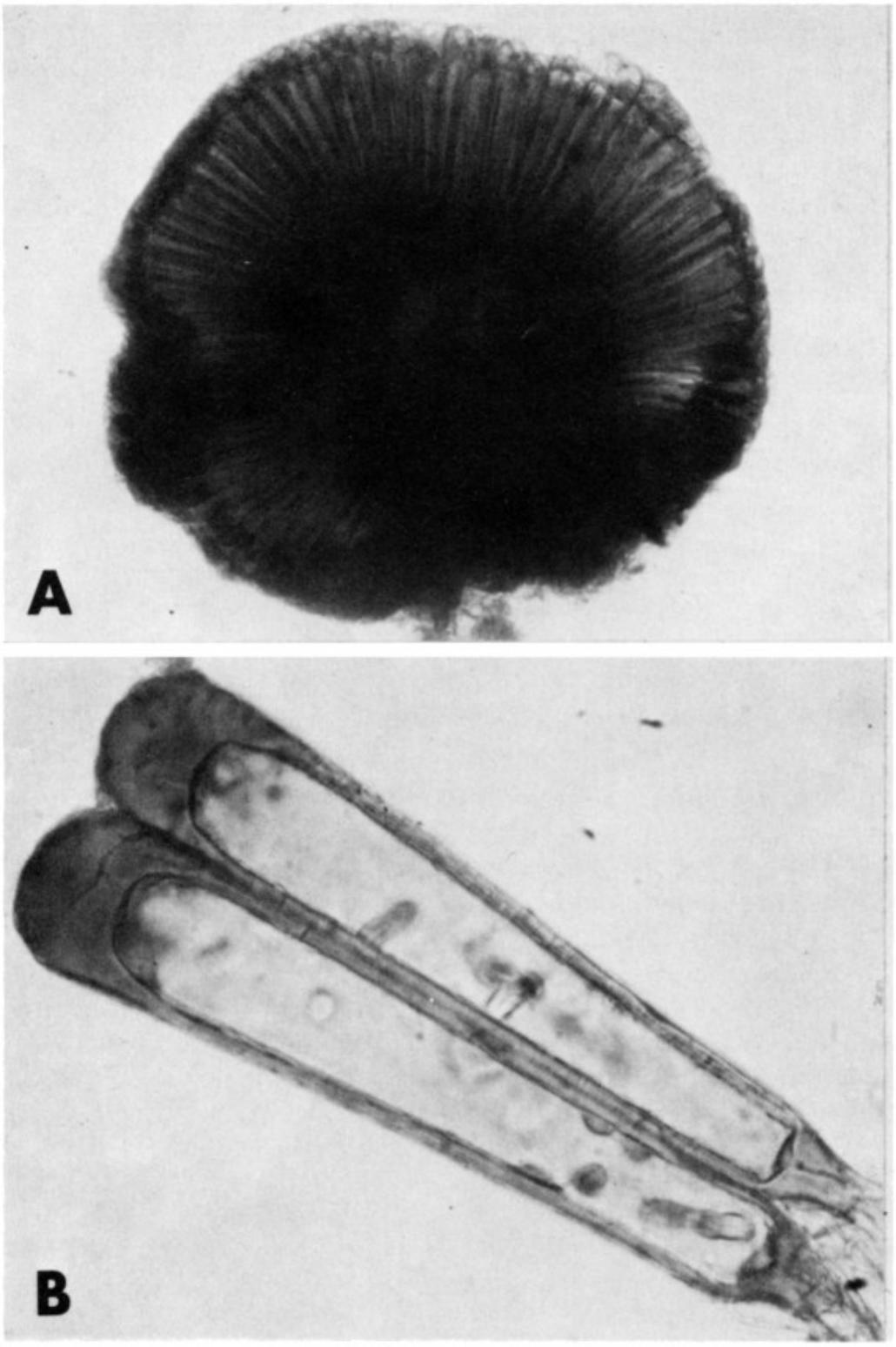

Fig. 1. *Sclerocystis clavispora:* (A) Sporocarps in cross-section, with long chlamydospores formed radially from central plexus, x100. (B) Chlamydospores, x500.

around a central plexus of hyphae; base indented; peridium lacking. *Chlamydospores* brown 140-185 x (20-) 25-40 (-50) µm, clavate to subcylindric, tapering to a hyphal attachment 7-10 µm diam. Spore walls 1.5-5 µm thick on the sides, at the spore apex thickened to 17-25 µm, at the base thickened to 5-8 µm and occluding the attachment at maturity. Reaction to Melzer's reagent not distinctive. *Central plexus* 150-450 µm diam, of tightly interwoven, pale brown, thin-walled hyphae 3-10 µm diam.

DISTRIBUTION AND HABITAT: Tropical Mexico, in pastures and fields.

MYCORRHIZAL ASSOCIATIONS: Associated in the field with roots of grasses and *Saccharum officinarum* L.

ETYMOLOGY: Latin, *clavispora* (clavate spored).

COLLECTIONS EXAMINED: TYPE: MEXICO - Veracruz: 40 km south of Catemaco near Hueyapan among roots of grasses and forbs, 13 July 1972, Trappe 3568 (OSC, isotype ENCB). PARATYPE: *Oaxaca*: Salinacruz, South of Jesús Carranza in grass field, 12 July 1972 (OSC).

Sclerocystis rubiformis Gerd. & Trappe is the only other species of the genus known to lack a peridium. The narrowly clavate spores with uniquely thickened apical walls of *S. clavispora* separate it readily from *S. rubiformis*. These spore characters can be used as an insertion for *S. clavispore* in couplet 1 of the key to species of *Sclerocystis* in Gerdemann and Trappe (1974, p. 60).

A species similar to *S. clavispora* has been reported from India by Thapar and Khan (1973), figs. 19-21, 30, 33) and Bakshi (1974, Pl. XII, figs. 17-19). These authors do not describe the pattern of spore wall thickening, however, and I have not seen their material. Its identity thus remains uncertain.

GLOMUS CONSTRICTUS Trappe sp. nov. Fig. 2A.

Chlamydosporae subglobosae vel globosae, 150-330 µm diam, fuscae vel nigrae; parietibus fuscis, 7-12 (-15) µm crassis; basibus rectis vel infundibuliformibus. Hypha affixa recta vel recurvata, ad basim sporae 20-30 µm diam, prope sporam typice constricta ad 10-17 (-22) µm, sub constrictio typice tumida ad 15-30 µm et hyphis tenuibus protrudentibus, sub tumore dichotome furcata. Peridium destitutum. Typus: Mexico, Veracruz, Trappe 3574 (OSC).

Chlamydospores naked, formed singly or in loose clusters in soil, subglobose to globose, 150-330 µm diam, dark brown to black, shiny-smooth. Spore walls 7-12(-15) µm thick, dark brown, one-layered or occasionally seeming two-layered; base straight or occasionally with a short funnel-shaped projection; attachment occluded by wall thickenings; contents of oil globules of widely varying sizes. Reaction to Melzer's reagent not distinctive. Attached hypha straight to recurved and with the following features appearing in sequence away from the spore: point of attachment with dark brown walls 3-6 µm thick; just beyond the point of attachment the hypha constricted to 10-17(-22) µm diam; just beyond the constriction, the hypha inflated to 15-30 µm diam with yellow to yellow-brown walls 2-3 µm thick, from which often grow several hyaline to yellow, fragile, thin-walled hyphae 5-7 µm diam; just beyond the inflated segment often with a thick-walled septum; and beyond the inflated segment the hypha dichotomously forked.

DISTRIBUTION AND HABITAT: Central California in irrigated soils to Guadeloupe (Leeward Islands) and tropical rain forests of Mexico.

MYCORRHIZAL ASSOCIATIONS: Associated in the field with roots of *Cocos*, *Citrus*, and *Persea* spp., *Zea mays* L., and grasses.

ETYMOLOGY: Latin, "constricted," referring to the typical constriction of the attached hypha near the spore base.

COLLECTIONS EXAMINED. TYPE: MEXICO - Veracruz: San Andrés Tuxtla, Catemaco, in soil under *Cocos nucifera* L. on grounds of U.N.A.M. Biol. Sta. Headquarters, 9 July 1972, Trappe 3574 (OSC; isotype, ENCB). PARATYPES: UNITED STATES - California: Fresno Co., 13 Jan. 1976, leg. J. Menge, Trappe 4999 (OSC); Santa Barbara Co., Carpinteria, May 1974, leg. G. A. Zentmyer, Trappe 3920 (OSC); San Diego Co., Fallbrook, 8 April and May 1974, leg. G. A. Zentmyer, Trappe 3892 and 3915 (OSC). MEXICO - Hidalgo: Tulancingo, 4 Aug. 1972, Trappe 3829 (OSC, ENCB); Veracruz: Boca del Rio, 10 Sept. 1972, Trappe 3607 (OSC); Tabasco: Cardenas, 12 July 1972, Trappe 3589 (OSC); Chiapas: Ixtacomitán (camino Pichucalco-Chiapa de Corzo), 13 July 1972, Trappe 3791 (OSC). GUADELOUPE - Guadeloupe Nat. Forest, Camp Jacob, 7 Jan. 1974, leg. S. Carpenter and D. H. Pfister, Pfister 1060A (FH, OSC).

Glomus constrictus spores resemble those of *G. macrocarpus* var. *geosporus* (Nicol. & Gerd.) Gerd. & Trappe, but the distinctively, often recurved, constricted and then inflated attached hyphae of *G. constrictus* contrast with the straight,

simple attached hyphae of the other. The two sometimes occur together, so that in a field collection the base and attached hypha of each spore must be examined to separate them. However, *G. constrictus* typically has a cluster of soil particles held tightly to the spore base by the fine hyphae that usually grow out from the inflated part of its attached hypha. This provides a quick and reasonably reliable way to separate it from *G. macrocarpus* var. *geosporus*, which usually is clean at the spore base. Some spores of *G. constrictus* have a funnel-shaped base similar to that of *G. mosseae* (Nicol. & Gerd.) Gerd. & Trappe, but the latter has yellow to brown spores divided from the attached hyphae by a septum, and its spores are often enclosed in a peridium.

In the key to species of the genus *Glomus* (Gerdemann and Trappe 1974, p. 38-40), *G. constrictus* might key out in two different places. In dichotomy 3 it can be separated from *G. mosseae* by its dark brown to black color and constricted, then inflated attached hypha. In dichotomy 15, it can be separated from *G. macrocarpus* var. *geosporus* by the elaborate structure of its attached hypha.

The wall structure, lack of inner membranes or soil-borne vesicles, and content of variably sized oil globules of spores of *G. constrictus* are all typical of the genus *Glomus*. Its constricted and then inflated attached hypha, however, mimic the bulbous, suspensor-like cells at the base of spores of *Gigaspora* spp. (Gerdemann and Trappe 1974). In *Gigaspora heterogama* (Nicol. & Gerd.) Gerd. & Trappe, this suspensor-like cell is recurved as often is the attached hypha of *Glomus constrictus*. The dichotomous fork of the attached hypha a short distance below the base of *G. constrictus* spores resembles the conjugation of undifferentiated hyphae that produces a stalked zygospore in the genus *Dispira* (Dimargaritaceae, Mucorales) (Benjamin 1959, 1961). These features of *G. constrictus* may be merely coincidental, but its life cycle needs to be worked out to determine if it represents any phylogenetic ties between *Glomus*, *Gigaspora*, the zygosporic genus *Endogone*, or the Mucorales.

ACAULOSPORA SCROBICULATA Trappe sp. nov. Figs. 2B-2C

Sporae singulae in solo efformatae, sessiles, gestae a latere hyphae latae in vesiculo globoso prope terminatae. Sporae globosae vel subglobosae, 100-240 x 100-220 µm, olivaceae vel brunneolae, depressionibus 1-1.5 x 1-3 µm scrobiculatae.

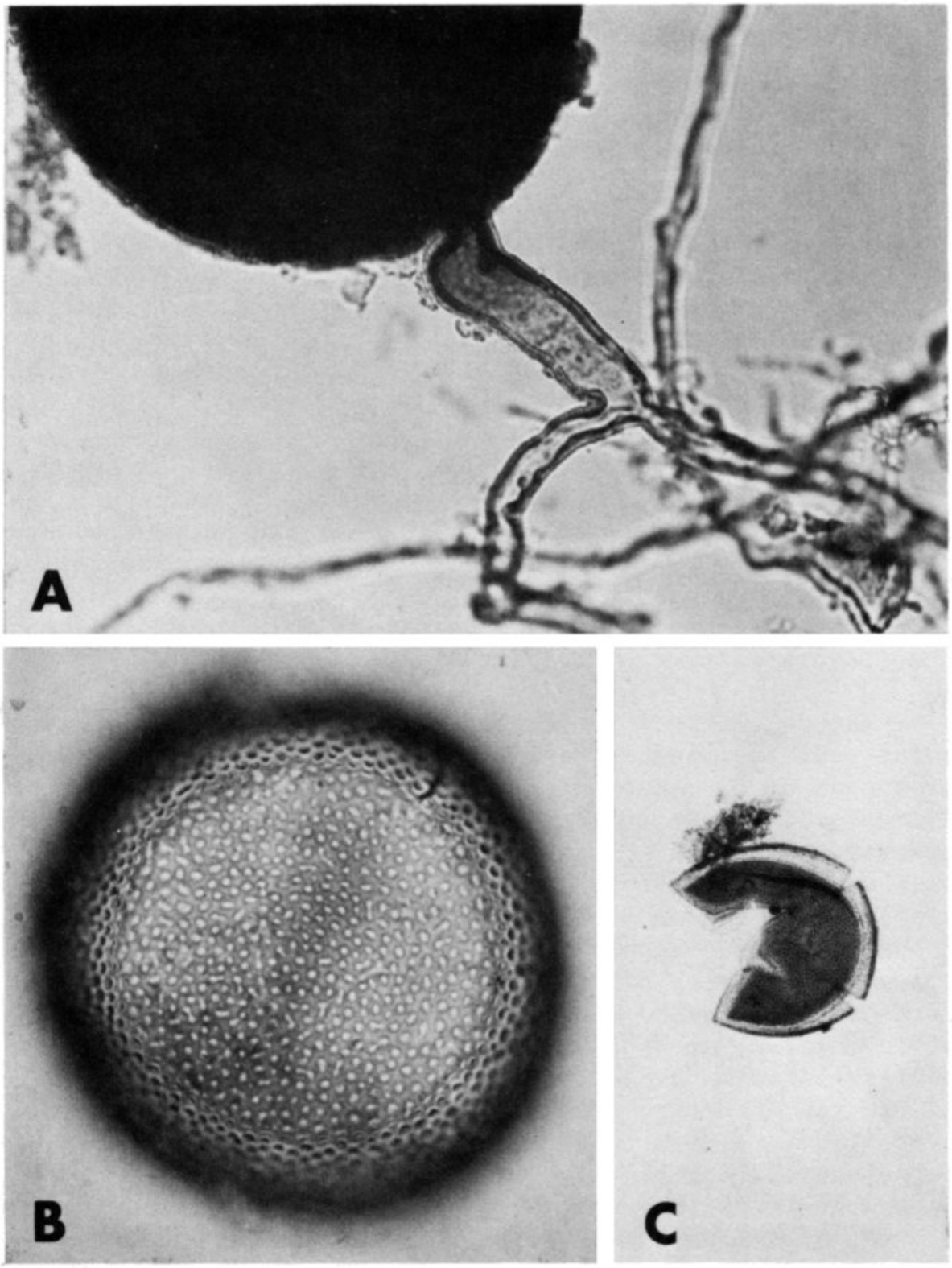

Fig. 2. (A) *Glomus constrictus*, showing constriction of hypha at attachment to spore, x350. (B,C) *Acaulospora scrobiculata*: (B) Pitted spore surface, x400; (C) crushed spore in Melzer's reagent, with innermost wall layer darkened, x 100.

Sporae tunica stratis quatuor: exteriore scrobiculato, dilute primulino, 3-6 µm crasso; secundo adhaerenti, hyalino, 0.2-0.5 µm crasso; tertio adhaerenti, hyalino, 0.5-1 µm crasso; interiore disjuncto, hyalino, interdum minute asperulo, 0.2-1.0 µm crasso, iodo rubescenti. Typus: Mexico, Chiapas, Trappe 3795 (OSC).

Sporocarps unknown. *Azygospores* forming singly in soil, sessile, borne laterally on a wide, thin-walled, hyaline hypha that terminates nearby in a thin-walled vesicle. *Vesicle* globose, 100-160 µm in diam, becoming empty and collapsing by spore maturity. *Spores* globose to broadly ellipsoid, 100-240 x 100-220 µm subhyaline in youth, becoming light olive to light brown at maturity. Spore surface evenly pitted with depressions 1-1.5 x 1-3 µm, separated by ridges 2-4 µm thick, the mouths of the depressions circular to elliptical or occasionally linear to Y-shaped. Spore wall continuous except at the circular, rimmed vesicle attachment ±15 µm diam and consisting of four layers: (1) the rigid, pitted, subhyaline to light greenish yellow outer layer 3-6 µm thick; (2) an adhering but separable, smooth, hyaline layer 0.2-0.5 µm thick; (3) an adhering but separable, smooth, hyaline layer 0.5-1.0 µm thick; and (4) a separated, sometimes minutely roughened, hyaline inner layer 0.2-1.0 µm thick. Spore contents of small, relatively uniform guttules. Reactions to Melzer's reagent: outer three spore wall layers yellow, innermost layer quickly becoming deep red on contact.

DISTRIBUTION AND HABITAT: Rain forests, road banks, and sugarcane fields of the Mexican tropics and central highlands, maize fields and subalpine meadows of central and western USA, and lowlands of central Japan. Koske (1974) has described a "yellow punctate" spore from Australian sand dunes that fits the description of *A. scrobiculata*.

MYCORRHIZAL ASSOCIATIONS: Associated in Mexico with roots of *Saccharum officinarum* L. and wild grasses, in the U.S. with *Zea mays* L. and *Festuca viridula* Vasey, and in Japan with wild grasses.

ETYMOLOGY: Latin, "minutely pitted," referring to the spore surface.

COLLECTIONS EXAMINED: TYPE: MEXICO - Chiapas: Ixtacomitán (Camino Pichucalco-Chiapa de Corzo), 13 July 1972, Trappe 3795 (OSC; isotype, ENCB). PARATYPES: UNITED STATES - Washington: Columbia Co., Oregon Butte, 20 Aug. 1975, leg. Paul Tresham, Trappe 4538 (OSC). Oregon: Union Co., Indian Creek Meadow, 14 Aug. 1975, leg. Gerald Strickler, Trappe 4537 (OSC); Wallowa Co., Wallowa Mountains, Standley Pasture,

15 July 1975, leg. Gerald Strickler, Trappe 4494 (OSC). Illinois: Mason Co., Kilbourne, 4 Oct. 1976, leg. Wm. Becker, Trappe 4998 (OSC). MEXICO - Mexico: 5 km E. of Toluca, 23 June 1972, Trappe 3861 (OSC). Veracruz: 5 km NE of Orizaba, 7 July 1972, Trappe 3604 (OSC). JAPAN - Shiga: Ótsu, Tomi-kawa, 3 July 1975, Trappe 4265 (OSC).

The red reaction of the innermost spore wall layer in Melzer's reagent is unique to *A. scrobiculata* among the Endogonaceae described to date. This reaction combined with the light colored, pitted spore wall readily distinguish *A. scrobiculata* from other *Acaulospora* spp. as described by Gerdemann and Trappe (1974) and Ames and Linderman (1976).

ACKNOWLEDGMENTS

Dr. Gastón Guzmán, Instituto Politécnico Nacional, E.N.C.B., Mexico, Dr. Teóphilo Herrera, Universidad Nacional Autónoma de México, and Dr. Tsuguo Hongo, Shiga University Faculty of Education, Japan, generously hosted the author in forays in their respective countries. The photographs of *G. constrictus* were provided by Dr. John Menge, University of California, Riverside. The research was supported in part by grants from the American Philosophical Society and the Japan Society for the Promotion of Science.

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Published November 4, 1977