Rev. Biol. Trop., 24(1): 109-121, 1976

Ecology, anatomy and redescription of Laternea pusilla

by

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(Received for publication November 20, 1975)

Abstract: *Laternea pusilla,* found on rotting logs in Costa Rica (Central America) is redescribed. The receptacle is formed by 2, 3, or 4 arms instead of just 2 as originally reported. Comparative ecological observations of the species during several months, in its natural habitat and at different altitudes and environments are presented.

Anatomical studies show that the receptacle of *L. pusilla* originates from primordial tissue above the rhizomorph. Initially the receptacle forms a chambered unit which branches into 2, 3, or 4 arms, similarly chambered. The branches finally encompass the gleba, which is swept up and left suspended underneath the arch of the receptacle arms. As the fruiting body develops, the outer chambers of the arms are disrupted and form the crests of the mature body, while the upper inner chambers give rise to the trabecular structure that holds the lantern and the suspended gleba.

Laternea is shown to be the valid name for the genus rather than *Colonnaria* Raf., which is either a synonym of *Clathrus* or a third genus. *Colonnaria pereximia* L. D. Gómez, on the basis of the variability of *Laternea pusilla* as to the number of arms of the receptacle, is considered synonymous with the latter.

The genus *Laternea* was established by **Turpin** (1822) to contain *Laternea triscapa,* and **Berkeley** and **Curtis** (1869) described *L. pusilla* based on two sporophores found in Cuba and now in the Kew Gardens Herbarium. **Patouillard** (1903) reported the finding of *L. pusilla* in Martinique and Guadeloupe, although his species description is questionable. **Linder** (1928) reviewed the genus and concluded that it should be considered monotypic, valid only for *L. triscapa* and that many species erroneously included in the genus should be transferred to the genus *Clathrus.* Many species have nevertheless been included in the genus *Laternea,* confusing the taxonomy of the genus and that of the Phallales (**Fischer,** 1886, 1891, 1893, 1900). **Dennis** (1953) made a more detailed description of *L. pusilla* from material collected four years earlier in Jamaica. More recently **Gómez** (1974)

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reported a new Clathraceous species as *Colonnaria pereximia* L. D. Gómez, from specimens which were originally classified by the author as *Laternea pusilla.* Dr. D. M. Dring (personal communication) agrees with the latter point of view. **Rafinesque's** (1808) original description of *Colonnaria* is unacceptable because it is poor and questionable; it runs as follows: *"Colonnaria (urceolata & truncata . . .)* divided into four pillars united at the top, which bear the seeds in the margin." This description could be applied to several genera of the family clathraceae, and **Cunningham's** (1931) rejection of Rafinesque's description is clearly justified; **Ainsworth** (1963) considers *Colonnaria* a *nomen dubium.* **Fischer** (1933) based *Colonnaria* on *Clathrus columnatus* Bosc (1811) = *Laternea columnata* (Bosc) Nees v. Esenbeck (1858) = *Colonnaria columnata* (Bosc) E. Fischer. Dr. D. M. Dring (personal communication) indicates that he "normally does not separate *Colonnaria* [as based on *C. columnatus* Bosc] from *Clathrus* . . . because it often has branched arms and there is no specialized glebiferous tissue." In my opinion, this is the proper interpretation. However, "if *P. columnatus* is separated from *Clathrus,* then its name should be *Colonnaria* for reasons of priority", rather than *Linderia* Cunningham [as in **Dring,** 1973]. **Santesson** (1943) adopting the latter point of view, clearly illustrated and described *Colonnaria* as having smooth arms and the specific gleba tissue commonly becoming " . . . entirely mucilaginous and disappeared with the spore mass, so finally there is nothing to indicate its earlier existence." This is not the case in *L. pusilla,* in which the specific glebiferous tissue or "lantern" remains after spore dispersal, except when it has been eaten by predators. **Zeller** (1949) recognized *Clathrus, Colonnaria* and *Laternea* as three separate genera. On the basis of the above information Gómez's specimens and mine should be classified as *Laternea.*

The purpose of this paper is to describe the anatomy and development of the fruiting body and to redescribe the species to complement earlier descriptions. **(Berkeley & Curtis,** 1869; **Patouillard,** 1903; **Dennis,** 1953), and also to communicate for the first time the culture and ecological observation of a phalloid during several months in a seminatural environment.

MATERIAL AND METHODS

A log covered with moss, bearing abundant mycelium and two sporophores of *L. pusilla* Berk. & Curt, was collected in a wet low montane forest at 2300 m in July 1973, near El Cedral, San José, Costa Rica. The original log was cut in two, leaving abundant mycelium in both parts. One part, Log # 1, was transferred to a moist shady environment, similar to its natural habitat, at 1235 m and observed daily for several months. The other part, Log # 2, was placed under a mango tree *(Mangifera indica)* at 975 m in a more windy and sunny environment. No special treatment was given to this log. Log # 1 was exposed to a humid medium either by rain or by daily watering. After two months Log # 1 was protected with a fine porous cloth, and insecticide (Bayer Baygon spray) applied around and under the log. After six months Log # 1 was moved to the same locality as # 2 but placed in a shady spot protected from sun and wind and watered daily. Completely developed fruiting bodies were obtained from Log # 1 and freeze-dried. Fruiting bodies in different stages of development were fixed in FAA and embedded in paraffine after dehydration in a TBA series. Longitudinal and serial cross sections 10 µm thick were made and stained with safranin-fast green. About a year later

two additional specimens, GL 904, JASR & MNC 1858 11-8-75, Cartago, Costa Rica, were collected at 1200 m from a similar substrate. Initially the more mature fruiting body appeared to be a new species since it had four arms which were not fused at one point but forming two arches, each supporting part of the gleba. The arches were connected by a short bridge 5 mm in length (Fig. 4). The other unopened fruiting body from the same mycelium was placed in a moist chamber to obtain, three days later, a three-armed receptacle.

Duplicates were deposited in the herbaria of the University of Costa Rica (JASR & MNC 1572) and the Royal Botanic Gardens, Kew, England.

OBSERVATIONS

Morphology: *L. pusilla* presented abundant white mycelium forming several branched rhizomorphs that traversed the rotting wood (Fig. 5), its natural substrate. Unopened "eggs" are obovoid, 1 cm wide and 1.5 cm tall and occur singly or in clusters connected at their base by rhizomorphs under the moss mat. In younger eggs the delicate outer portion of the peridium splits in flakes that fall at maturity (Fig. 1), although in some cases they may remain adherent. The peridium is whitish with a mucilaginous layer 2-3 mm thick. During development the receptacle ruptures the peridium which remains as the volva, and emerges as a spongy structure composed of 2, 3, or 4 arms united at the apex (Figs. 1, 4) and free at the base, where they are weakly joined to the volva above the rhizomorph. The total height of the open, mature fruiting body ranges from 2 to 4.5 cm. Hand cross sections of the arms show them to be composed of pseudoparenchyma, with cells having a thick wall. The arms are 2-3 chambered, pale red, cylindric, pitted and almost smooth in the lower half. Longitudinal sections show the arms to be composed of cavities irregularly distributed. In some mature fruiting bodies there are vestiges of internal crests below the apex, which joined the arms during early stages of development. At maturity the gleba is located under the apical portion of the receptacle on a differentiated structure or "lantern" which is longitudinally furrowed and connected to the arms by trabecula-like structures that might be considered as internal crests of the arms (Figs. 2, 4); the "lantern" is hollow with open ends and of a deeper color. This structure may well be named an internal or hanging pileus. In my opinion, the lantern originates from the upper internal chambers of the receptacle which are protected from dehydration during development because they are covered by the gleba, while the same chambers at the lower internal part of the receptacle are disrupted and dehydrated as the receptacle develops its branches, leaving just vestiges of their presence.

The gleba is dark olive, almost black, with the characteristic unpleasant odor of phalloids. Spores are 3-4 x 2 μm smooth, bacilloid, and greenish.

Anatomy: Longitudinal microtome serial sections of immature eggs, 3 mm in diameter, show the volva to be composed of two layers (Figs. 6, 7). The outer layers, 80-160 μm wide, usually form flakes that split at maturity (Fig. 1). They are composed of prosenchymatous tissue of loosely interwoven hypahe; the internal layer is 300-500 μm wide and composed of the same kind of tissue, although of thinner and clearer hyphae (Fig. 6). The gleba, surrounded by primordial tissue is labyrinthian and occupies four-fifths of the section (Figs. 6, 7). At this stage there is no evidence of any other structure in this series. Series of excentric longitudinal sections of another egg 5 mm wide show the base of the rhizomorph to be 1 mm

wide and composed of prosenchymatous tissue; immediately above it, the first stages of the receptacle can be clearly seen arising from the primordial tissue (Figs. 10, 11). At a still later stage, several vertical elongate chambers may be seen at the base of the receptacle, which eventually branches into 2, 3, or 4 arms. The outer chambers of each arm are evidently disrupted to form the crest of the mature fruiting body, while the upper inner chambers give rise to the trabecular structures that hold the "lantern" with the suspended gleba (Figs. 1, 8, 9). Later the arms encompass the gleba, forcing it upward and leaving it suspended underneath the arch of the receptacle (Figs. 1, 3, 4). A fourth series of longitudinal sections shows a heart-shaped gleba, with the apparently immature "lantern" in its notch, and opposite peridial sutures (Figs. 10, 11). It is certainly surprising to note that the "lantern" develops after the gleba.

Ecology: The presence of 2, 3, to 4 arms in the receptacle was confirmed in both natural and semi-natural situations. The ratio of individuals with 2 arms to those with 3 was 1:5. The activity of predators and climatic changes, particularly variations in relative humidity, may account for the low number of fruiting bodies usually found in nature. On the other hand, protection of Log #1 with cloth and insecticide, besides the constant humid environment, accounted for the large number of fruiting bodies obtained in a semi-natural situation (16 fruiting bodies in 5 months). Log #2, lacking moisture, in a windy environment and unprotected from predators failed to produce fruiting bodies. It was found that predators are attracted by the odor of the gleba and rupture the peridium before the eggs open naturally. They eat the receptacle and the gleba, leaving the volva like an empty shell. Fruiting bodies obtained in dry periods of the rainy season were in general smaller. When Log #1 was moved to the same locality as Log #2, and kept moist for more than a month, only two eggs were obtained, but neither reached maturity. They were aparently affected by the low relative humidity and higher temperature of the new habitat. Although Log #1 produced a fairly large number of fruiting bodies before protection, most of them never reached maturity because of predator action.

DISCUSSION

Apparently *L. pusilla* requires a very high relative humidity, low temperature (16-20 C) and a shady place to grow and fructify. This explains why all collections are obtained during the rainy season. In nature these conditions are provided by the moist low planes of the forest and by the mosses that usually cover the logs. Altitude may not be an important factor. I have found the species from 1600 to 2300 m. Under the conditions of this study sporophores were obtained at 1200 m. Here receptacles with three arms were more characteristic than those with two. Fruiting bodies with four arms may be found, although they are less common than those with two or three arms. It was also observed that sporophores are originated at different times of the year, whenever environmental conditions are appropriate. These conclusions can apparently be applied to all other phalloids that are found in similar habitats. Since the same mycelium can, as the present experiments show, give rise to 2-, 3-, or 4-armed, otherwise similar fruiting bodies, the distinction between *L. pusilla* with two arms and *L. pereximia* with three, loses significance. In my opinion *L. pereximia* (*C. pereximia* Gómez) is a synonym of *L. pusilla*. Dring, as stated earlier, agrees with this view.

This work also demonstrated that it is not possible to accept new species descriptions of Clathraceae based on only one or two fruiting bodies.

RESUMEN

Se redescribe *Laternea pusilla* encontrada en madera en descomposición en Costa Rica (América Central). El receptáculo está formado por 2, 3, o 4 brazos en vez de 2 como se comunicó originalmente. Se informa sobre observaciones ecológicas comparativas de la especie, realizadas durante varios meses en su habitat natural, así como en diferentes altitudes y medios.

Los estudios anatómicos muestran que el receptáculo de *L. pusilla* se origina del tejido primordial, por encima del rizomorfo. En su origen, el receptáculo es una estructura con cámaras que se ramifica luego en 2, 3, o 4 brazos igualmente con cámaras. Las ramas finalmente rodean la gleba, la levantan y finalmente la dejan suspendida por debajo del arco que forman los brazos del receptáculo. Conforme el cuerpo fructífero se desarrolla, las paredes de las cámaras externas de los brazos se rompen y originan las crestas del cuerpo fructífero adulto, mientras que las cámaras internas superiores dan origen a las trabéculas que sostienen o suspenden la "linterna" y la gleba.

Se considera *Laternea* Turpin el nombre válido para el género, más que *Colonnaria* Raf., que parece ser aplicable más bien a *Clathrus* Mich. & Pers. *Colonnaria pereximia* Gómez se estima sinónimo de *L. pusilla,* con base en la variabilidad de esta especie en cuanto al número de brazos del receptáculo.

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Figs. 1-4. *Laternea pusilla.*

Fig. 1. Eggs developing in the natural substrate. Note unopened eggs with exoperidium flakes and two-armed receptacle in which the external chambers have not broken yet to form the crests. The gleba is being swept up with elongation of the arms.

Fig. 2. The fruiting body shown in fig. 1 has reached here its full development; the crests are now formed and the "lantern" is held in place by trabecular-like structures.

Fig. 3. A three-armed receptacle seen from above. Note crests, the junction of the arms at the top, and the gleba below.

Fig. 4. A four-armed recetacle. Gleba, rhizomorphs and volva are shown. Figs. 2 and 4 show freeze-dried specimens.

1

2

3

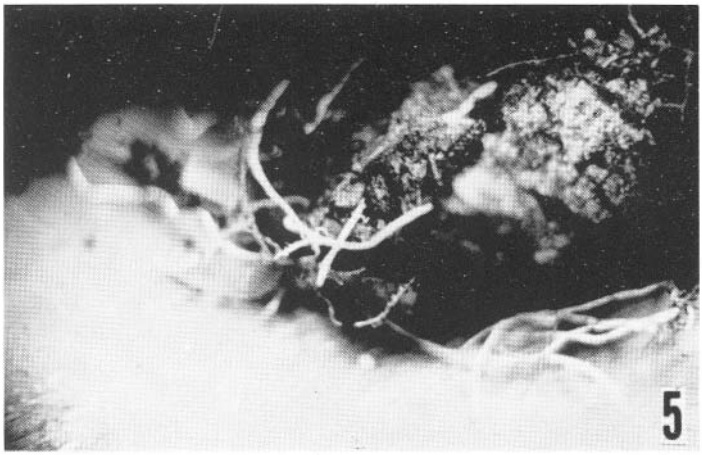
4

Figs. 5-7. *Laternea pusilla.*

Fig. 5. Rhizomorphs emerging from the natural substrate.

Fig. 6. Cross-section of fruiting body showing internal layer of the peridium; primordial and hymenial tissue in the labyrinthine gleba.

Fig. 7. Section of fruiting body showing the two peridium layers.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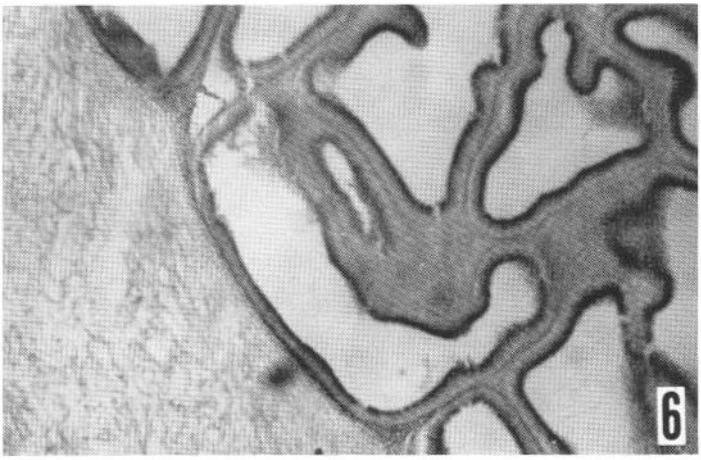
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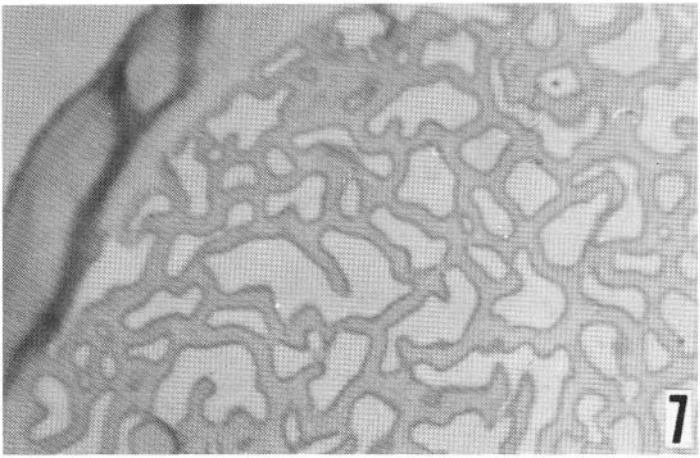
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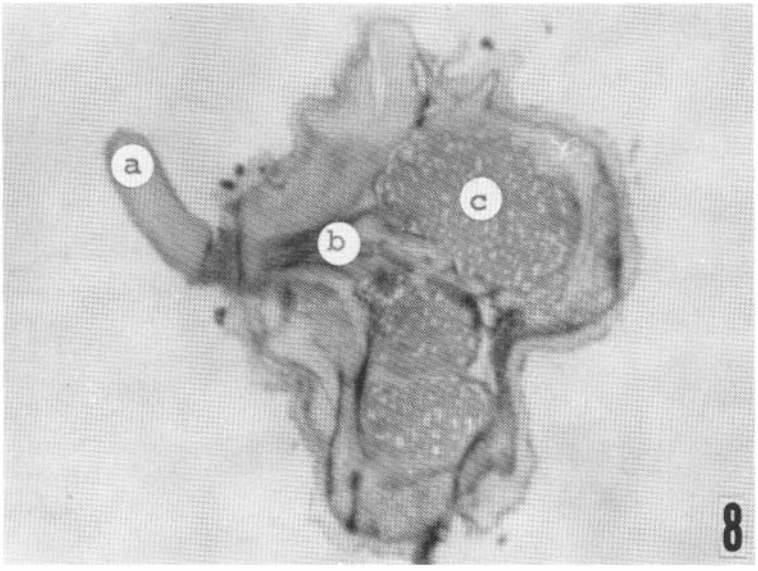
Figs. 8-9. *Laternea pusilla.*

Fig. 8 Longitudinal section of fruiting body, showing: a, rhizomorph; b, origin of the chambered recetacle branched at the apex; and c, gleba divided in three parts.

Fig. 9. Detail of fig. 8 showing: a, the prosenchymatous tissue of rhizomorph; and b, chambers of the undeveloped recetacle.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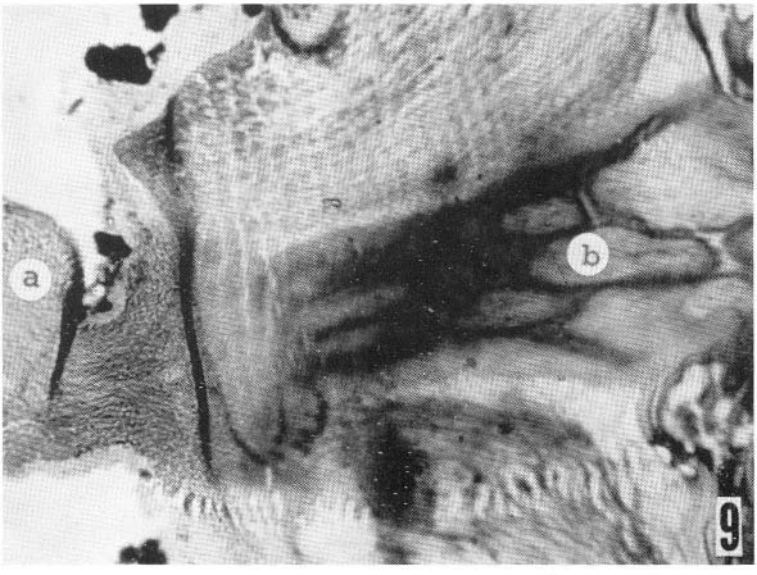
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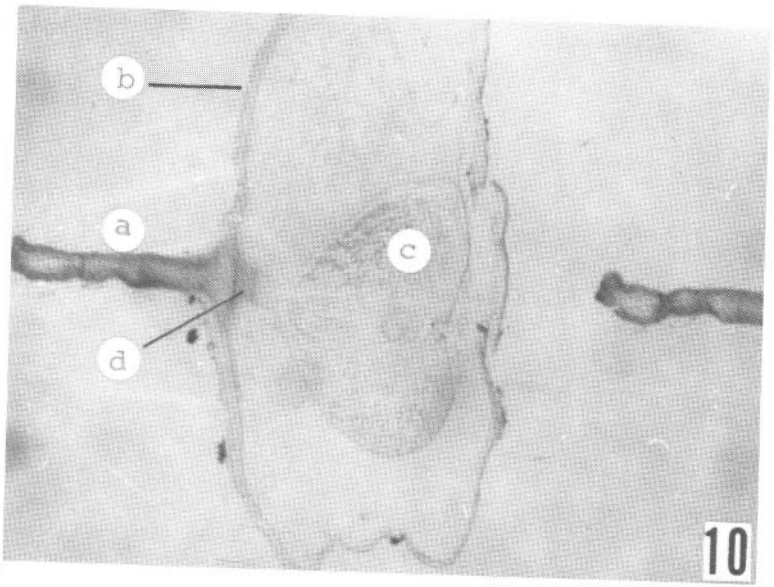
Figs. 10-11. *Laternea pusilla.*

Fig. 10. Longitudinal section showing: a, rhizomorph; b, peridium; c, heart-shaped gleba; d, early stages of receptacle development.

Fig. 11. Longitudinal section of another egg, showing: a, two opposite peridial sutures; b, formation of first chambers of the receptacle; and c, gleba.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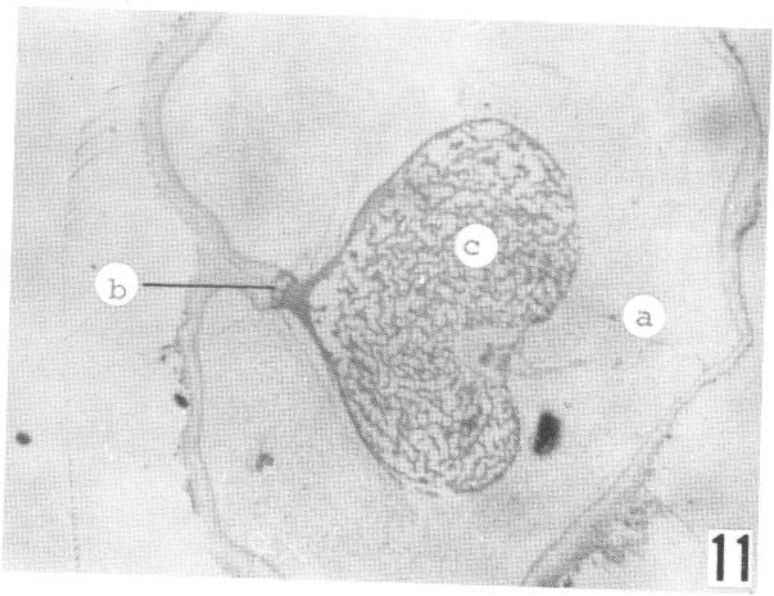
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