THE STRUCTURE AND RELATIONSHIP OF URNULA GEASTER

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(WITH PLATE XII AND THREE FIGURES)

During the season of 1909 the writers found an interesting ascomycete growing abundantly in the vicinity of Austin, Texas. On attempting to identify the species it was traced to *Urnula geaster* Peck,[1] which was collected at Austin, in 1893, by Dr. L. M. UNDERWOOD and sent to Mr. C. H. PECK for identification, but the characters observed did not agree with PECK's description in several important points. For this reason a package of fresh specimens was sent to Mr. PECK, who replied that they were the same as the original *Urnula geaster* which he had previously described, but that his description was lacking in a number of important points, since only dried specimens had been available for making the original diagnosis. This description has been corrected by Mr. PECK[2] in his recent report, in accordance with the examination of fresh specimens sent to him by the authors.

Since this fungus has recently been made the basis of a new genus, *Chorioactis*,[3] and the material used for the study consisted only of dried herbarium specimens, the careful study of its anatomy was undertaken to determine the validity of its separation from Urnula.

Habitat

The ascomata of *Urnula geaster* are found growing, either singly or in groups, from roots and portions of stumps of the small-leaved elm (*Ulmus crassifolia*) which are old and somewhat disintegrated. They may be clustered close to the base of the stump, or they may originate from the roots at some point distant from it. In all cases the stipe or stalk of the apothecium comes from a point 5–10^{cm} below the surface of the ground.

[1] SACCARDO, P. A., Sylloge Fungorum **11**:422. 1895.

[2] PECK, C. H., Report of N. Y. State Botanist for 1908. pp. 31, 32. 1909.

[3] KUPFER, E. M., Bull. Torr. Bot. Club **29**:142. 1902.

According to the original description, the fungus was recorded as growing on the "ground"[4] (ad terram).[5] The writers have examined a large number of specimens in the field, and in every case a direct connection with subterranean roots could be established. The ease with which the stipe breaks from its point of attachment and also the depth of the roots in the soil may have been the cause of the original error in observation.

Structure

The brown septate hyphae grow over the surface of the decaying wood as a loose network, or become aggregated into strands or compact layers in intimate contact with the surface of the root.

Specimens of the apothecia have been collected in the cooler months, from October to April. Their appearance only during this portion of the year is undoubtedly due to the favorable conditions of moisture and temperature. The apothecia can generally be found in abundance following a short rainy season during the period mentioned. They begin their development, however, in May or June and grow slowly through the dry summer period, reaching maturity in the months mentioned above. This last observation was contributed by Professor W. H. LONG, Amarillo, Texas, and has been confirmed by the writers.

The mature apothecium while still closed is rather thick club-shaped (*text fig. 1*), with a stalk or stipe shorter than the apothecial cavity or equaling it in length. While this is the typical form, specimens which originate from deep-lying roots may have much longer stipes; others growing from more superficial roots may be nearly sessile and rather globular in form (*text fig. 2*). The apothecia before dehiscence vary in diameter from 1.2 to 3.5^{cm} in the broadest portion, and in length from 4 to 12^{cm}. The stalk varies from 0.75 to 1.5^{cm} in diameter and is 1–5^{cm} in length. The outer surface of the entire fructification is covered with a dense chocolate-brown tomentum. The cut surface of the stalk and wall is pure white, while the hymenial layer is yellowish white (28),[6] becoming with age light leather colored (8).[6] The fresh apothecia are of a soft leathery texture, becoming firmer with desiccation.

[4] PECK, C. H., Report of N. Y. State Botanist **46**:39. 1893.

[5] SACCARDO, P. A., *l. c.* 422.

[6] *Ibid.*, Chromotaxia. 1894.

As soon as the apothecium reaches maturity, the wall begins to show several longitudinal fissures, which ultimately separate the hymenial portion into 4–6 segments or rays (*text fig. 2*). These rays begin to curve outward as soon as they become separated at the tips, and may come to stand at right angles to the stipe (*text fig. 3*). This position of the rays gives the open apothecium a Geaster-like appearance. In the case of deep-seated apothecia, the rays do not become

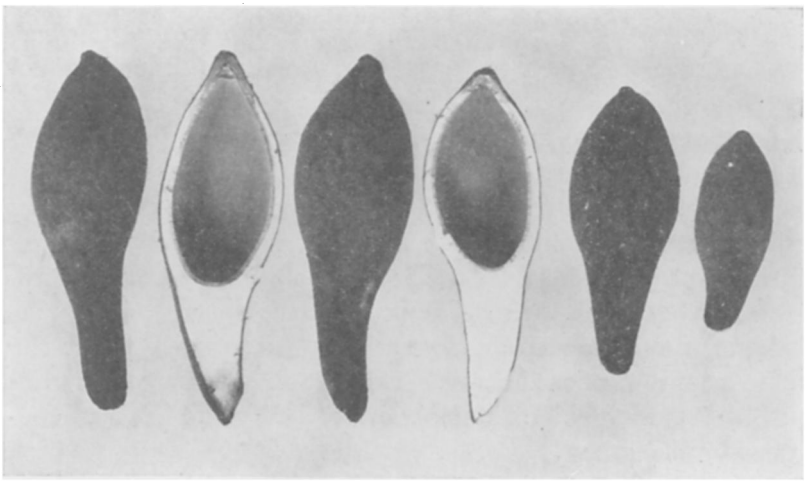

FIG. 1.—A series of ascomata of *Urnula geaster;* two of them bisected to show the extent of the apothecial cavity and the stipe.

completely recurved, since their movement is partially prevented by contact with the surrounding soil.

Soon after the dehiscence of the apothecium, dustlike clouds of spores may be seen to rise in puffs from the exposed hymenial surface. This characteristic expulsion of the spores, together with the form and color of the fruiting structure, has secured for the fungus the popular name of the "devil's cigar." A somewhat similar expulsion of spores has been noted in various species of Peziza, Helvella, and Bulgaria.[7] The puffing of the spores is apparently due to loss of moisture, since mature open specimens show the characteristic puffing when removed from a damp chamber to air of the room. While this is probably

[7] MASSEE, G., Textbook of Fungi 110. 1906.

the normal cause of the expulsion of the spores, the same phenomenon may be induced by the release of tension due to breaking the rays. After the spores have been expelled, the release of the tension in the hymenial surface causes the segments of the apothecium to be raised and curled inward (*text fig. 2*).

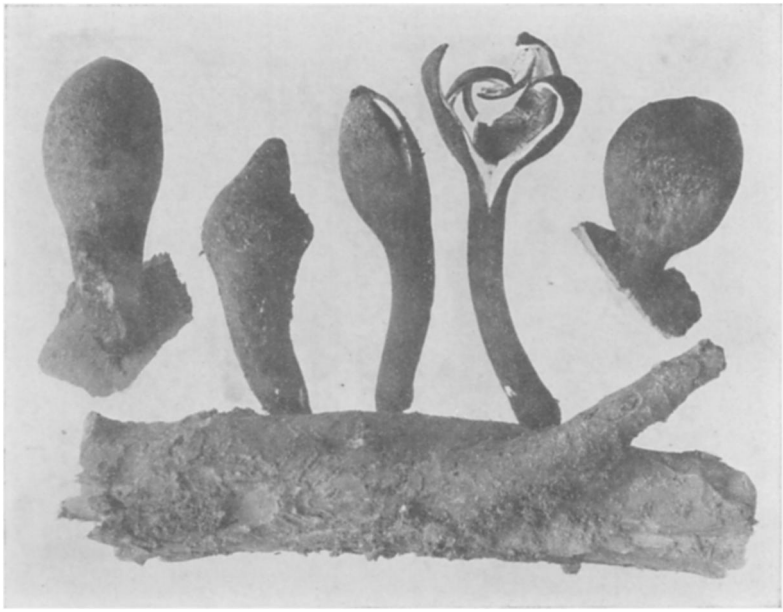

FIG. 2.—Apothecia of various forms, showing origin from roots and the manner of dehiscence.

The wall of the apothecium is thick, reaching 3.5^{mm} in many cases. The original description does not specify the thickness, while KUPFER[8] gives 2.5^{mm} as the extreme measurement. This difference may be explained easily by the fact that only dry material was available in all the previous studies.

The wall of the apothecium shows in section a region of brown hairs, about 0.1^{mm} in thickness, which is the cause of the brown tomentose exterior. Just below the hairy layer is a relatively narrow cortical zone made up of densely interwoven hyphae, while the remain-

[8] KUPFER, E. M., Bull. Torr. Bot. Club **29**:143. 1902.

der of the wall consists of a loosely interwoven network of filaments which become denser and more closely aggregated in the hypothecial region. The wall, including cortical portion, medullary portion, and hypothecium, may be 2.5^{mm} in thickness, and the hymenium may be 0.75–0.85^{mm} in thickness. It should be noted in this connection that the apothecial wall is composed of distinct hyphae, and that they are never aggregated to form a pseudoparenchyma. This fact is directly opposed to the observations recorded by KUPFER,[8] stating

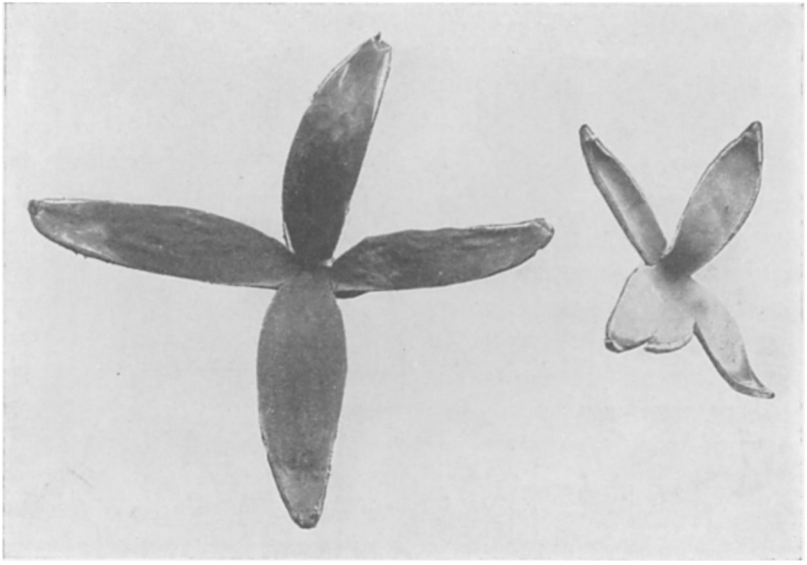

FIG. 3.—Apothecia viewed from above, showing the Geaster-like appearance.

that "the tissue is made up wholly of large parenchymatous cells." She even gives the measurements of these cells and they are also illustrated in the plate accompanying the paper. The size of these so-called parenchymatous cells agrees practically with our measurements of the intercellular spaces in the immature specimens as shown in *fig.* 7.

The erroneous observation mentioned above is without doubt due to the fact that the dry specimens, which were the only ones used, were not completely mature. Previous to the dehiscence of the apothecium the hyphae which make up the wall are very small in

diameter, being about 1.5 μ. *Fig. 7*, which was drawn from fixed (chromacetic acid) and imbedded material from young specimens, might easily have been interpreted as representing a pseudoparenchyma. After the dehiscence of the apothecium, the hyphae constituting the wall enlarge rapidly to 3–6 times their diameter in young specimens, reaching a thickness of 4.5–9 μ (*fig. 8*). At this stage it would seem almost impossible for even the most careless observer to interpret the structure as a pseudoparenchyma, since the hyphae are so large that even in dried specimens they could not be mistaken for cell walls. Even in the most compact part of the subhymenium the hyphae and intercellular spaces are easily distinguished (*fig. 4*).

The asci are 700–800 μ in length and 14–17.25 μ in diameter. This is somewhat in excess of the measurements given for *Urnula craterium*,[9] the type specimen of the genus. The ascus is nearly uniform in diameter and shows a short characteristically curved basal portion. This character and the origin of the asci from the subhymenium is shown in *fig. 4*. The free end of the ascus is bluntly rounded and shows an apical pore which permits the rupture of the wall when the spores are expelled. The eight continuous hyaline spores are confined to the upper two-thirds of the ascus, and are arranged with their tips slightly overlapping, but in a single series. They are oblong-fusiform and distinctly flattened on one side, 54–68 μ long by 10–13 μ wide; each spore contains 3–5 prominent guttulae (*fig. 5*). Numerous branched septate paraphyses are present, which are uniform in diameter throughout (slightly less than 2 μ) and do not show a terminal enlargement as figured by KUPFER (*l. c. pl. 8. fig. 4*).

Systematic position and relationship

As a result of a comparative study of several species of Urnula and Geopyxis, KUPFER (*l. c.* 142) has made *Urnula geaster* Peck the type of the new genus Chorioactis. The basis for the separation is stated as follows: "That it is not an Urnula seems to me just as evident from its external appearance as from an examination of its tissues. A comparison of internal characters shows, however, that there is no possible relation with *Urnula craterium*. The tissue is

[9] SACCARDO, P. A., Sylloge Fungorum **8**:549. 1890.

made up wholly of large parenchymatous cells, those of the excipulum averaging 34 μ in diameter, those of the hypothecium 10–14 μ." In our study of the structure of *Urnula geaster* we have shown, by detailed examination of material fixed in chromacetic acid and stained with iron alum-hematoxylin, that the wall of the apothecium is not parenchymatous, but composed of distinct interlacing hyphae with prominent intercellular spaces. The supposed parenchymatous wall was the main character which separated *Urnula geaster* from *Urnula craterium*, the type of the genus. Since this supposed character was based entirely upon erroneous interpretation of the structure, there can be little ground for the establishment of a new genus. A comparison of some of the characters of *Urnula geaster* and *Urnula craterium* will indicate still further that there is little ground for this separation.

	Urnula craterium (Schw.) Fries	*Urnula geaster* Peck
Size	3–7·5×7^{cm}	1·2–3·5×4–12^{cm}
Asci	400–500×14–15 μ	700–800×14–17·25 μ
Spores	23·33×8–13 μ	54–68×10–13 μ
Consistency	Leathery	Leathery
Wall of apothecium	Interlacing hyphae	Interlacing hyphae

The agreement of our specimens with *Urnula craterium*, the type of the genus as established by FRIES, makes impossible any separation of the species under discussion from the genus Urnula. Therefore the original name of *Urnula geaster*, as given by PECK, should be retained.

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EXPLANATION OF PLATE XII

FIG. 1.—Portion of cross-section of the apothecium, showing the different layers. ×15.

FIG. 2.—A single ascus with branched paraphysis. ×83.

FIG. 3.—A single ascus, showing the position of spores. ×330.

FIG. 4.—Origin of paraphyses and asci from the subhymenium. ×330.

FIG. 5.—A single spore showing empty spaces from which the reserve food in the form of oil has been dissolved. ×330.

FIG. 6.—Tip of ascus showing apical pore. ×660.

FIG. 7.—Interlacing hyphae from the wall of the apothecium preceding dehiscence. ×330.

FIG. 8.—Interlacing hyphae from the wall of a mature open apothecium. ×330.