Koichiro MIURA*: Notes on filamentous fungi from Japan (§ 9)**

三浦宏一郎*: 日本産の糸状菌類 (§ 9)**

§ 9. The genus **Cochlonema** (Zoopagales).

The fungi belonging to the genus *Cochlonema* are endoparasites of rhizopods. This genus was established in 1935 on the type of *C. verrucosum* by C. Drechsler and, up to the present time, seventeen species and one variety have been added to this genus mostly by the same author. And, most of these fungi have been recorded only from U. S. A. In this section, I will report seven species, including one unidentified fungus, collected from our country and discuss some morphological characteristics of the genus.

Infection Some species are parasites of testaceous rhizopods; the rests are of amoebae. Infection of the host is initiated by germination of a conidium which either adheres to the outer surface of the animal or is ingested by it. In most species, a young thallus develops from the top of a delicate germ-tube, but in *C. euryblastum* it bursts out directly from the conidium. Germination is terminal, subterminal or lateral. The spore membrane of germinated conidium is caducous in some species, but it is marcescent in others.

Thallus and assimilative hypha The thallus develops within the cell of the host animal; it consists of a single assimilative hypha. The assimilative hypha is hyaline, simple or branched, coiled, continuous at first, but, after initiation of reproductive development, it becomes progressively evacuated and septate from the distal end. In the view point of make-up of the thallus, at least two types of thalli are distinguishable within the genus.

1) Cochleate thallus. As the assimilative hypha elongates, it coils outwards from the tip. So, the outermost end of the thallus is youngest. Branching is dichotomous. Bifurcation takes place in the plane perpendicular to that of the first coil. But, in a number of species, the first dichotomy is in the plane of the first coil or somewhat oblique to that plane.

* Bot. Inst., Fac. Sci., Tokyo Kyoiku Univ., Otsuka, Tokyo. 東京教育大学理学部植物学教室.

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2) Circinate thallus. The assimilative hypha coils inwards. The outermost end is oldest. Branching, if present, is much less regularly dichotomous than is usual in the cochleate thallus. It seems rather monopodial.

In *C. bactrosporum* and *C. fusisporum*, the hypha coils like a spiral spring and branches dichotomously (Drechsler, 1939). For these species, the third type of thalli may be defined. Under the binominal *C. explicatum*, Drechsler (1955) described an ectoparasite with a non-convoluted, dichotomously branched thallus. But the fungus "might advantageously be made the type of a separate genus...." As pointed out by Drechsler, the eventual size of thallus, the number of times of bifurcation and the number of turns of convolution vary greatly within any given species depending not only upon the size of the host animal but also upon the number of thalli coexisting in the animal. Notwithstanding the variability, these features exhibited by well-developed thalli are of some specific diagnostic value.

Asexual reproduction Asexual reproduction is by means of true conidia formed in chains. The conidiophores are hyaline, mostly branched, proximally prostrate and distally erect or ascending. In amoeba-parasitic forms, as pointed out by Drechsler, the number of conidiophores arising from a thallus may vary depending upon the size of thallus. One conidiophore develops from a position near the proximal end of the thallus and additional ones, if present, arise from the convex side of thallus at variable intervals in positions successively closer to the distal tip. Two types of conidiophores, characterized by external appearance of the aerial part, may be distinguished within the genus.

1) Moniliform conidiophore. The aerial part of conidiophore exhibits narrowed constrictions at more or less regular intervals set off a series of swollen portions with minute verrucose sculpturing. In young conidiophores, it was repeatedly observed that the terminal swelling was formed as a blown-out end of the lower, last-formed one. The aerial part of conidiophore seems to grow through repetition of the acropetal budding-out process. The conidiophore is converted into a spore chain through evacuation of protoplasm from the constrictions. The conidia are hyaline and non-septate. Form and size of conidia vary considerably within a single chain. The conidia in the lower portion of a chain are generally longer, narrower and less pronouncedly verrucose than those in the median and distal portions.

In *C. fusisporum*, conidia are always smooth (Drechsler, 1939).

2) Filamentous conidiophore. The aerial part of conidiophore does not exhibit any external modification. Segmentation of conidiophore seems to be brought about through spaced evacuation of protoplasm at regular intervals and deposition of endwalls by the separated protoplast. The conidia are cylindrical and smooth.

In the manner of conidial chain formation, *C. lineare* seems to be quite distinct from any other congeneric forms (Jones, 1962).

Sexual reproduction Sexual reproduction takes place by the union of zygophoric hyphae. The zygophoric hyphae of amoeba-parasitic forms are hyaline, simple or branched, very similar to conidiophores in position of origin and in width of their proximal portions, and more or less expanded toward their distal ends. The septum delimiting the gametangium is clearly observable in some species, but in others presence or absence of it is obscure. Origin and behaviour of paired zygophoric hyphae, as well as form and size of each hypha, are of some specific diagnostic value. A young zygote appears as a spherical body from one of the paired hyphae at some distance from the place of conjugation. In *C. agamum* and *C. euryblastum*, zygotes (azygotes) are formed parthenogenetically. Within the Zoopagales, two types of zygotes (zygospores) are recognized. In this genus, both are found to occur.

1) Thick-walled zygote. Mature zygotes (=zygospores) are globose, thick-walled and ornamented with prominent protuberances. The protuberances are thimble-shaped, hemispherical or lobed (columnar with apical lobes); they furnish a more reliable supplementary criterion for separating and delimiting related species.

2) Thin-walled zygote. Mature zygotes are somewhat polyhedral and thin-walled, each including a single bullate zygospore.

Often, it is very difficult to identify a specimen without sexual apparatus nor mature zygotes.

Cochlonema agamum Drechsler, 1946, Mycologia **38**: 132. (Fig. 1, A–I).

Assimilative hyphae coiled compactly into a cochleate form of $1^1/_4-2$ turns, simple or dichotomously branched up to 3 times in succession, 3.5–10.0 μ wide, each putting forth 1–2 (mostly 1) reproductive hyphae. Conidiophores 0.9–1.7 μ wide near the base, usually ramifying immediately after perforating the pellicle, growing into the air without prostrating for a long

distance, moniliform in aerial part. Conidia fusiform to cylindrical with truncate ends, nearly always verrucose, 6.0–11.5 μ long, 1.5–2.3 μ wide. Zygophoric hyphae simple or branched in the same manner as the conidiophores; distal cells (equivalent to gametangia) cylindrical to clavate, usually somewhat crooked, 27–40 μ long, 4.5–7.0 μ wide, each budding forth an azygotes laterally or terminally. Azygotes globose, 9.4–13.7 μ across, thick-walled, ornamented with 20–40 hemispherical protuberances. Infection by ingestion of conidia. Germ-tube terminal or subterminal. Empty spore membrane marcescent.

Parasitic on amoebae mostly 50–90 μ across, occurring in forest soil collected by Mr. S. Tokumasu in Hitoyoshi, Kumamoto Pref. in November 1968.

My material agrees very well with the original description and the figures given by Drechsler except for frequent terminal development of azygotes. Often, it is very difficult to detect the empty spore membrane.

Cochlonema calosperma Drechsler, 1951, Mycologia **43**: 167. (Fig. 2, A–H).

Assimilative hyphae coiled into a cochleate form of $2^1/_2$–3 turns or more, dichotomously branched 2–3 times or more in succession, 2.3–8.2 μ wide, each putting forth up to 7 reproductive hyphae; width of branches of assimilative hyphae being noticeably reduced in each dichotomy. Conidiophores simple or branched, 1.0–1.5 μ wide near the base, moniliform in aerial part. Conidia elongate-fusoid to cylindrical with truncate ends, rarely branched, nearly always verrucose, 7.5–22.5 μ long, 1.0–2.1 μ wide. Zygophoric hyphae simple, 2.7–5.1 μ wide near the apex; paired zygophoric hyphae originating from separate thalli, winding about one another in some helicoid turns, occasionally entangled one another somewhat irregularly. Zygotes globose, 9.7–12.0 μ across, thick-walled, ornamented with about 30 lobed protuberances. Empty spore membrane caducous.

Parasitic on amoebae occurring in leaf-mould collected near Cape Ashizuri-zaki, Kôchi Pref. in August 1967.

Germination of conidia was not observed. Among the detached conidia, longer ones were often provided with a terminal empty appendage which was formed through withdrawal of protoplasm from one end of the spore and deposition of a septum. My material agrees rather well with the original description.

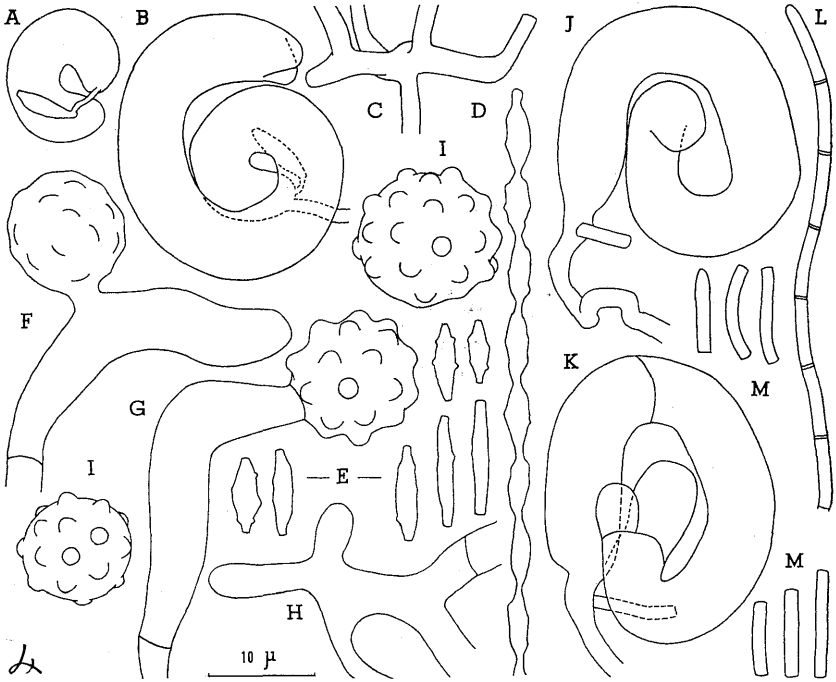

Fig. 1. A-I. *C. agamum.* A. Young thallus. B. Mature thallus. C. Ramification of conidiophore immediately after perforating the pellicle. D. Aerial part of conidiophore. E. Conidia. F-G. Zygophoric hyphae and young azygotes. H. Ramification of zygophoric hypha immediately after perforating the pellicle. I. Mature azygotes. J-M. *C. cylindricum.* J-K. Mature thalli. L. Portion of spore chain. M. Conidia.

Cochlonema cylindricum Drechsler, 1937, Mycologia **29**: 247. (Fig. 1, J-M).

Assimilative hyphae coiled into a circinate form of $1-1^3/_4$ turns, simple or distally forked, 4.0-9.0 μ wide, each putting forth a single conidiophore. Conidiophores branched, 1.5-2.1 μ wide within the testa of the host, 0.9-1.5 μ wide out of the testa, filamentous in aerial part. Conidia cylindrical with truncate ends, smooth, 6.1-11.0 μ long, 1.0-1.3 μ wide. Infection by ingestion of conidia. Germination terminal; delicate germ-tube absent. Empty spore membrane marcescent.

Parasitic on testaceous rhizopods (*Euglypha* sp.) mostly 38-50 μ high, 23-35 μ wide occurring in moss cushion collected in Furano, Hokkaido in September 1967.

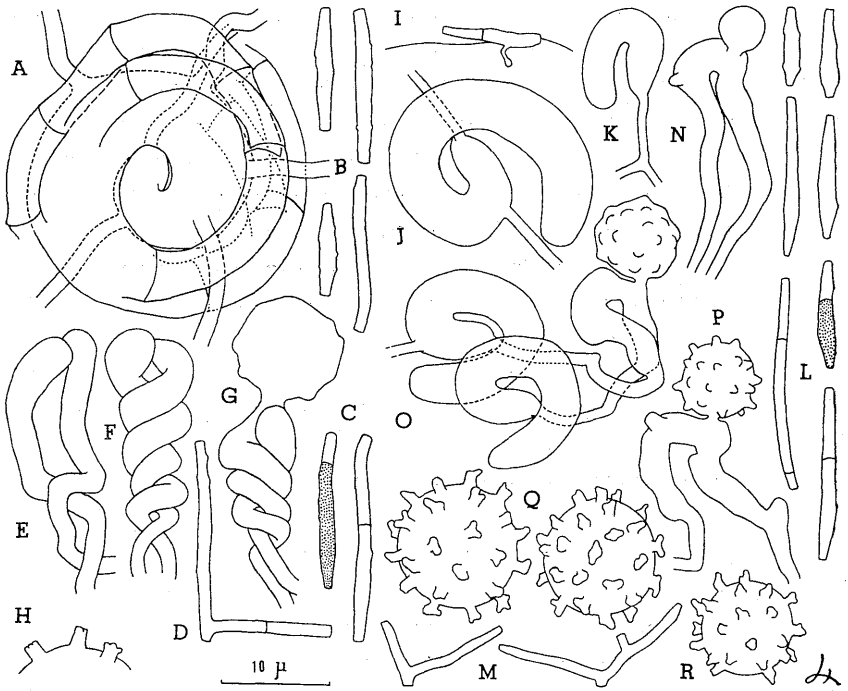

Fig. 2. A-H. *C. calosperma*. A. Mature thallus. B. Conidia. C. Conidia with a terminal empty appendage. D. Branched conidium. E-F. Paired zygophoric hyphae. G. Paired zygophoric hyphae with a young zygote. H. Lobed protuberances of zygote. I-R. *C. odontosperma*. I. Conidium sticked to the pellicle of the host. J-K. Mature thalli. L. Conidia. M. Branched conidia. N-P. Paired zygophoric hyphae and young zygotes. Q-R. Mature zygotes.

When observed, all the thalli had initiated their asexual reproduction. Sexual reproduction did not take place. My material agrees very well with the original description.

Cochlonema euryblastum Drechsler, 1942, Mycologia **34**: 287. (Fig. 3).

Assimilative hyphae coiled into a cochleate form of $1-1^1/_2$ turns, simple or once bifurcate, 3.0-12.0 μ wide, each putting forth a single (rarely two) reproductive hypha; bifurcation occurring in the plane of the first coil or somewhat oblique to that plane; curvature of hypha often decreasing progressively up to the first dichotomy. Conidiophores 1.4-2.5 μ wide near the base, ramifying immediately after perforating the pellicle, growing into the

air without prostrating for a long distance, moniliform in aerial part. Conidia lemon-shaped to fusiform with truncate ends, verrucose, 3.5–7.5 μ long, 1.3–2.0 μ wide. Zygophoric hyphae simple or branched; distal cells (equivalent to gametangia) irregularly expanded, rarely clavate, 16–25 μ long, 8–15 μ wide, each budding forth an azygote. Azygotes globose, 8.6–14.0 μ across, thick-walled, ornamented with 25–60 thimble-shaped protuberances. Infection by ingestion of conidia. Germination lateral; delicate germ-tube absent. Empty spore membrane marcescent.

Parasitic on amoebae mostly 35–55 μ across, occurring in moss cushion collected in Niihama, Ehime Pref. in July 1962; in decaying leaves collected in Usa, Kôchi Pref. in September 1964.

In vegetative and asexual structures, my materials agree well with the original description. This is the first record of the sexual reproduction of this species.

Cochlonema odontosperma Drechsler, 1937, Mycologia **29**: 233. (Fig. 2, I–R).

Assimilative hyphae coiled into a cochleate form of $^3/_4-1^3/_4$ turns, simple, 2.7–6.8 μ wide, each putting forth 1–3 reproductive hyphae. Conidiophores simple or branched, 0.9–1.2 μ wide near the base, moniliform in aerial part. Conidia fusiform to cylindrical with truncate ends, rarely branched, nearly always verrucose, 7.0–20.0 μ long, 1.0–1.8 μ wide. Zygophoric hyphae simple or branched, 2.6–3.7 μ wide near the apex; paired zygophoric hyphae originating from separate thalli. Zygotes globose, 6.8–11.4 μ across, thick-walled, ornamented with 25–45 lobed protuberances. Infection by adhesion of conidia. Germ-tube lateral. Empty spore membrane caducous.

Parasitic on amoebae mostly 25–45 μ across, occurring in grass-land soil collected by Mr. S. Tokumasu in Abashiri, Hokkaido in September 1970.

Branched thalli were not observed in my material. Among detached conidia, longer ones were often provided with a terminal empty appendage which was formed through withdrawal of protoplasm from one end of the spore and deposition of a septum. My material agrees well with the description and the figures given by Drechsler.

Cochlonema verrucosum Drechsler, 1935, Mycologia **27**: 19. (Fig. 4, A–G).

=*Cochlonema pygmaeum* Jones, 1959, Trans. Brit. Mycol. Soc. **42**: 81 (as *C. pygmaea*), syn. nov.

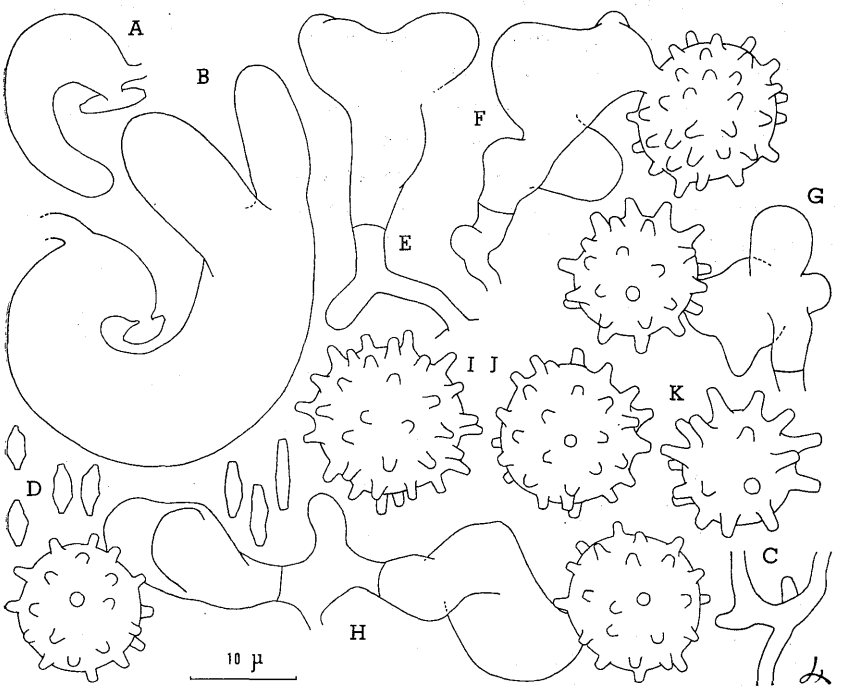

Fig. 3. *C. euryblastum.* A-B. Mature thalli. C. Ramification of conidiophore immediately after perforating the pellicle. D. Conidia. E. Young zygophoric hypha. F-H. Zygophoric hyphae and azygotes. I-K. Mature azygotes.

Assimilative hyphae coiled into a cochleate form of $1^2/_3$–$2^1/_2$ turns, simple or dichotomously branched up to 2 times in succession, 2.2–6.8 μ wide, each putting forth a single reproductive hypha. Conidiophores branched, 0.8–1.4 μ wide near the base, moniliform in aerial part. Conidia fusiform to cylindrical with truncate ends, nearly always verrucose, 3.8–7.1 μ long, 0.9–1.7 μ wide. Paired zygophoric hyphae originating from separate thalli. Zygotes globose, 11–13 μ across, thick-walled, ornamented with 20–40 hemispherical protuberances. Infection by ingestion of conidia. Germ-tube subterminal. Empty spore membrane marcescent.

Parasitic on amoebae mostly 30–60 μ across, occurring in wood-land soil collected near Cape Ashizuri-zaki, Kôchi Pref. in August 1967.

Conidial size of my material is a little smaller than that of the type

material. But, among 32 conidia drawn by Drechsler (1941, Fig. 5-G), at least ten conidia are apparently 5 μ or less in length. Sexual reproduction took place very meagerly in my material.

C. pygmaeum Jones was described from Kenya. This African fungus is very similar to *C. verrucosum* in general morphology. According to Jones, "this species is most readily separated from all other members of the genus by its small size." Comparison of size of thalli and conidia between the two species is as follows:

	C. verrucosum		*C. pygmaeum*
	Drechsler (1935)	Miura	Jones (1959)
Assimilative hyphae			
Number of turns of convolution	1-2(-3*)	$1^2/_3$-$2^1/_2$	$1^1/_2$-2
Number of times of bifurcation	0-2*	0-2	0
Width (μ)	4.5-7.0	2.2-6.8	2.5-4.0
Conidia			
Length (μ)	6-9**	3.8-7.1	3.5-6.0
Width(μ)	1.4-2	0.9-1.7	1.2-1.5

* Drechsler, 1941, Mycologia **33**: 263-265.
** See the discussion on the size of conidia of *C. verrucosum* in the text.

As discussed above, the width of assimilative hyphae, the number of turns of convolution and the number of times of bifurcation vary greatly within a species. Size of conidia varies within a single chain. And, we must go over the figure of conidia drawn by Drechsler (1941) in our mind. Thus, the size difference observed by Jones seems to be insufficient to separate his fungus from *C. verrucosum*. On the other hand, there is another point of difference between the two fungi. According to Drechsler, the germ-tube is lateral in *C. verrucosum*; the germ-tube of *C. pygmaeum* is terminal. But, the germ-tube of *C. verrucosum* often appears from a lateral position close to one end (Drechsler, 1935, Pl. 3, Fig. C-E). In my material, it was nearly always subterminal. Thus, I think *C. pygmaeum* is a synonym of *C. verrucosum*, although sexual reproduction of *C. pygmaeum* is unknown.

Duddington (1940) reported a cochlonema from England under the name

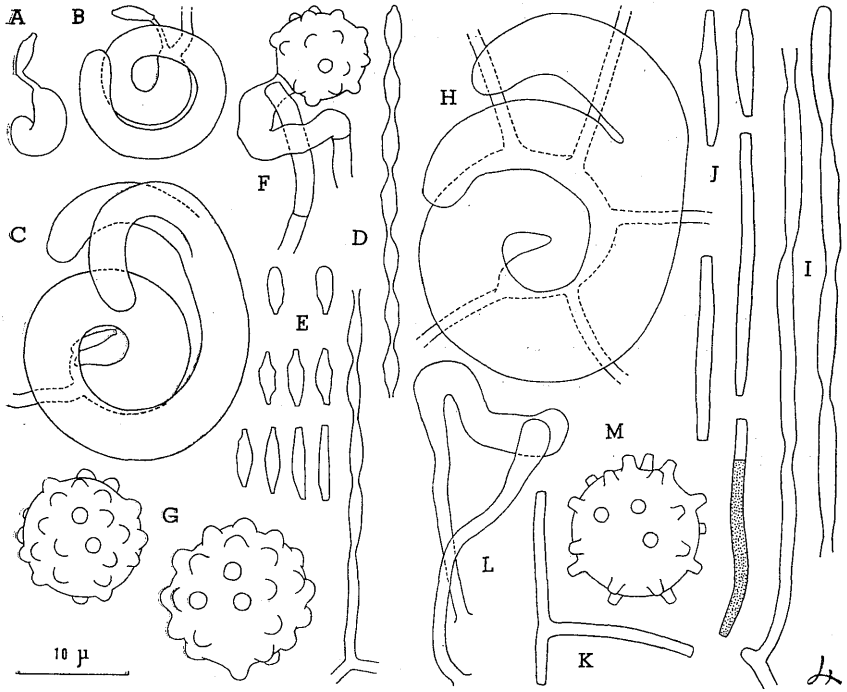

Fig. 4. A-G. *C. verrucosum.* A. Young thallus. B-C. Mature thalli. D. Aerial part of conidiophore. E. Conidia. F. Paired zygophoric hyphae with a young zygote. G. Mature zygotes. H-M. *C.* sp. H. Mature thallus. I. Aerial part of conidiophore. J. Conidia. K. Branched conidium. L. Paired zygophoric hyphae. M. Mature zygote.

C. verrucosum. According to him, his fungus attacked the host by means of conidia adhering to the pellicle. This is not an attribute of *C. verrucosum.*

Cochlonema sp. (Fig. 4, H-M).

Assimilative hyphae coiled into a cochleate form of $1^1/_4$-2 turns, simple or dichotomously branched 1-2 times in succession, increasing the width during elongation, attaining the maximum width when the growing tip has described one turn, 3-13 μ wide, each putting forth up to 6 reproductive hyphae; bifurcation occurring in the plane of the first coil or somewhat oblique to that plane. Conidiophores simple or branched, 1.2-1.6 μ wide near the base, moniliform in aerial part. Conidia elongate-fusoid to cylindrical

with truncate ends, rarely branched, 9–20 (–27) μ long, 1.1–1.9 μ wide. Zygophoric hyphae simple or branched, 3.6–5.4 μ wide near the apex; paired zygophoric hyphae originating from separate thalli. Zygotes globose, 11–13 μ across, thick-walled, ornamented with 30–35 thimble-shaped protuberances. Empty spore membrane caducous.

Parasitic on amoebae mostly 40–80 μ across, occurring in garden-soil collected from Koishikawa Botanic Garden, Tokyo in January 1964.

Germination of conidia was not observed. This fungus is very similar to *C. megalosomum* Drechsl. (1939), but this differs from it in having smaller conidia and smaller zygotes. Moreover, the host animal attacked by this fungus is about half the size of that attacked by *C. megalosomum*. So, it seems to be better to report this fungus as an unidentified one.

My hearty thanks are due to Mr. S. Tokumasu who kindly collected many soil samples for my use.

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Cochlonema 属（根足虫類内部寄生菌，ゾオパゲ目）に属する次の7種の菌類を，本邦菌類フロラに加える。いずれも原記載以後ほとんど記録がない。併せて，*Cocholonema* 属の形質を要約し，若干の分類学的検討を加えた。また *C. euryblastum* の有性生殖（azygote 形成）は初めての記録である。

1) *C. agamum* Drechsl. 2) *C. calosperma* Drechsl. 3) *C. cylindricum* Drechsl. 4) *C. euryblastum* Drechsl. 5) *C. odontosperma* Drechsl. 6) *C. verrucosum* Drechsl. (=*C. pygmaeum* Jones) 7) *C.* sp. (? *C. megalosomum* Drechsl.)

○*Camellia crapnelliana* の染色体数（近藤勝彦）Katsuhiko KONDO: The chromosome number of *Camellia crapnelliana*

Camellia crapnelliana Tutcher の染色体数はまだどの文献にもみられないのでここに記しておく。昨年 Dr. C. R. Parks は *C. crapnelliana* の種子をホンコンから導入，発芽育苗に成功した。そこで筆者にこの植物の染色体を調べるように言われたので，根端細胞を使って観察したところ，2n=30 を得，2倍体であることがわかった。我々は *C. crapnelliana* が *C. granthamiana* Sealy の片親であろうと考え，さらに観察を続けている。

（ノースカロライナ大学植物学科）