Korean J. Ecol., 23(4): 315~321, 2000

The Occurrence and Morphological Comparison of Dictyostelid Cellular Slime Molds in Mt. Muhak Soils

Hwang, Ji-Young, Hiromitsu Hagiwara* and Jong-Hee Kim

Department of Biology, Kyungnam University, Masan, 631-701, Korea,
*Department of Botany, National Science Museum, Amakubo, 305, Japan**

ABSTRACT: The occurrence and distribution of Dictyostelid cellular slime molds on Mt. Muhak soils with two different vegetation types were investigated. Two plating methods were used for the isolation of dictyostelids following Dr. Hagiwara's method. *Dictyostelium* and *Polysphondylium* were isolated in these soils. *D. purpureum* (subtropical form) and *D. giganteum* were observed in both *Quercus variabilis* and *Pinus thunbergii* communities soils. *D. delicatum, D. sp-1* (*D. brefeldianum* complex), *D. sp-2* (*D. brefeldianum* complex), *D. minutum* and *P. pallidum* complex occurred only in *Q. variabilis* soil. *D. macrocephalum, D. purpureum* (temperate form), *D. robustum, D. polycephalum, P. violaceum,* and *P. pallidium* occurred only in *P. thunbergii* soil. *P. pallidium* complex is being identified.

Key Words: Cellular slime mold, Dictyostelid, Mt. Muhak

INTRODUCTION

The cellular slime molds were first discovered in Europe by Brefeld, who described *Dictyostelium mucoroides* initially in 1869 and then *Polycephalum violaceum* in 1884 (Bonner 1967, Hagiwara 1984a, Raper 1984). The first comprehensive review of the cellular slime molds is the monograph on the Acrasieae by E.W. Olive, published in 1902 (Bonner 1967). Raper and Thom (1932) confirmed the presence of these slime molds in American soils that showed a similar pattern reported from Poland.

Dictyostelid cellular slime molds, or dictyostelids, are living primarily in the soil of fields and forests where they feed selectively on bacteria (Singh 1947, Cavender and Raper 1965a, b, c). The historical background and systematics of dictyostelids have been reviewed in great detail by Raper (1984). Hagiwara (1971) published his first paper on the Acrasiales of Japan, followed by other papers in which he expanded the list of known species in Japan while carefully noting habitats in which each species occurred (Hagiwara 1973, 1974, 1978, 1979, 1983, 1984b, 1984c, 1984d, 1986, 1989). Four species, *D. giganteum, D. purpureum, P. vioaceum* and *P. pallidum* were isolated from Uruguay (Piaggio 1989). Cavender *et al.* (1995) studied ecological distribution of cellular slime molds in forest soils of Germany.

Research for cellular slime molds in Korea started in 1980. Development of their population in natural ecosystem relies on various environments in micro-habitat. Their increase rate and diversity are especially under the influence of density and diversity of bacteria (Kuserk 1980, McQueen 1971). A report (Hong and Chang 1990), which analyzed their appearance and geographical distribution quantitatively in major deciduous forest areas in South Korea, divided the cellular slime molds from seven islands in West Sea near Inchon into seven species. And they also researched their distribution by vegetation types (Hong and Chang 1991).

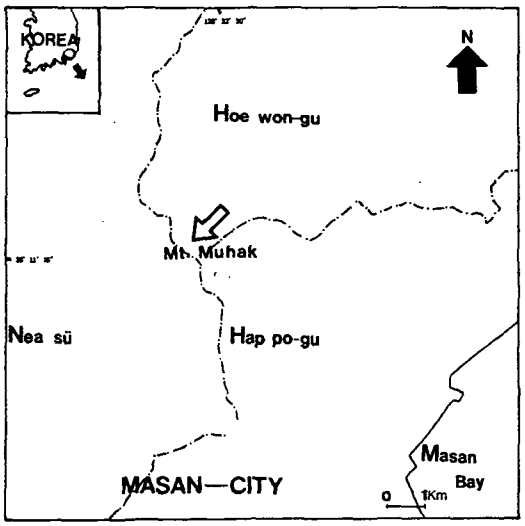
The objectives of this study are (1) to distinguish types of cellular slime molds, and (2) to search Dictyostelid in different vegetation types of Mt. Muhak.

MATERIALS AND METHODS

The soils were collected and processed for Acrasieae in an identical way to that reported by Cavender and Raper (1965). Samples were collected in Mt. Muhak (Elev. 767.4m above sea level, 35°11′15″N, 128°32′30″E) from soils of two different vegetation types, *Q. variabilis* community and *P. thunbergii* community (Fig. 1).

Soils were taken from humus and fermentation layers in each site. An isolation medium was made from hay (mainly rice straw) collected from fields. After a spore mass was transferred to a cultivation plate, a few drops of the suspension of pregrown *Escherichia coli* cells were put on the spore mass. Then the plate was incubated at 20℃. All the observations recorded were made of pure cultures developed on the cultivation plates.

Two plating methods were used for the isolation of dictyostelids as follows: 1) One part of a sample was put into a 300 ml flask containing



⇩ : The sampling site

Fig. 1. The map of sampling site.

50 ml of sterile distilled water and then suspended on a shaker at 120 rpm for an hour. The suspension was filtered through cotton gauze, and dropped on and then distributed over the surface of a isolation plate by a sterile L-shaped glass rod. 2) Small particles of samples were directly placed on and then spread over the surface of a isolation plate with a sterile glass spoon. Two replicates per sample were prepared by both of two methods and then incubated at 20℃ (Hagiwara 1989).

RESULTS AND DISCUSSION

Eleven species of cellular slime molds occurring in two different vegetation types were identified from Mt. Muhak. These species were: *Dictyostelium giganteum*, *D. macrocephalum*, *D. purpureum* (subtropical form), *D. purpureum* (temperate form), *D. robustum*, *D. delicatum*, *D. minutum*, *D. polycephalum*, *Polysphondylium violaceum*, *D. sp-1* (*D. brefeldianum* complex) and *D. sp-2* (*D. brefeldianum* complex)(Table 1).

Out of 11 species, *D. purpureum* (subtropical form), and *D. giganteum* were observed in both *Q. variabilis* and *P. thunbergii* communities soils. Seven species of the cellular slime molds were distributed throughout the *Q. variabilis* community, and eight species were found in the *P. thunbergii* community.

D. giganteum (Fig. 2) was characterized by long creeping sorophores (usually 17~25 mm long in length, occasionally up to 30 mm in length) and small white sori (Singh 1947). Sorocarps were mostly large, variable, and solitary. These were usually semi-erect or inclined under overhead light and prostrate in unidirectional lateral light. They had strong phototropism. Sorophores were thin, sinuous, and strikingly creeping in one-side illumination. The tips were simple capitate, and the base shape was conical. Spores were hyaline, oblong to elliptical, and having no polar granules. This species was isolated from the *Q. variabilis* and *P. thunbergii* communities soils. *D. macrocephalum* (Fig. 3) was only observed in the *P. thunbergii* community. This has been first isolated in Taiwan by Hagiwara (1985). Sorocarps were usually solitary, but sometimes they were gregarious or clustered. Sorophores were colorless, about 2 mm in length, and strongly tapering from bases to tips. The base type was conical, and the tips were obtuse to clavate in shape.

D. purpureum (Fig. 4) was one of the most cosmopolitan dictyostelid cellular slime molds (Raper 1984). Two forms of *D. purpureum* were recognized in Japan by Hagiwara. One of them was named "temperate form", which often makes large sorocarps, 6 mm in height and produces comparatively elongate spores (2.1<length/width <3.0). The other form was named "subtropical form" which has been obtained only from Okinawa in the most southern part of Japan (Hagiwara 1992).

Temperate forms and subtropical forms were isolated on Mt. Muhak. *D. robustum*, *D. polycephalum*, and *P. violaceum* were observed only from the *P. thunbergii* community in Mt. Muhak soils. *D. robustum* (Fig. 5) was macroscopically characterized by very large and robust sorocarps

Table 1. Distribution of cellular slime molds from Mt. Muhak

Species	Soil types (community types)	
	Quercus variabilis	*Pinus thunbergii*
Dictyostelium giganteum	○	○
D. macrocephalum		○
D. purpureum (subtropical form)	○	○
D. purpureum (temperate form)		○
D. robustum		○
D. delicatum	○	
D. minutum	○	
D. polycephalum		○
D. sp-1	○	
D. sp-2	○	
D. violaceum		○
D. pallidum complex	○	○

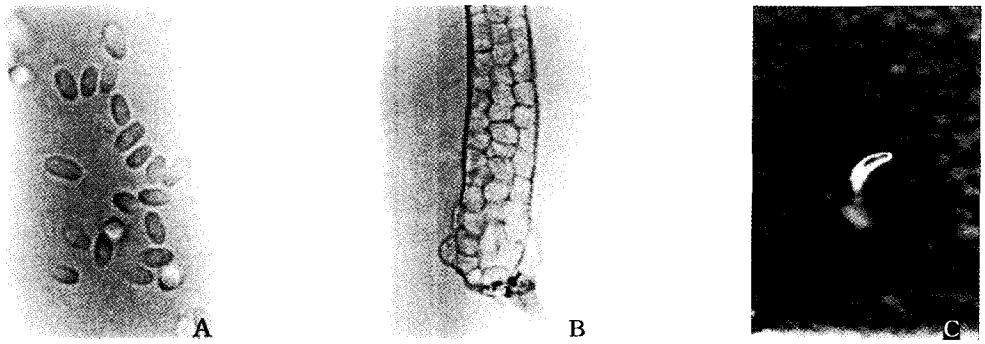


Fig. 2. *Dictyostelium giganteum.* A. Spores (×1000). B. Base (×400). C. Young sorocarps (×30).

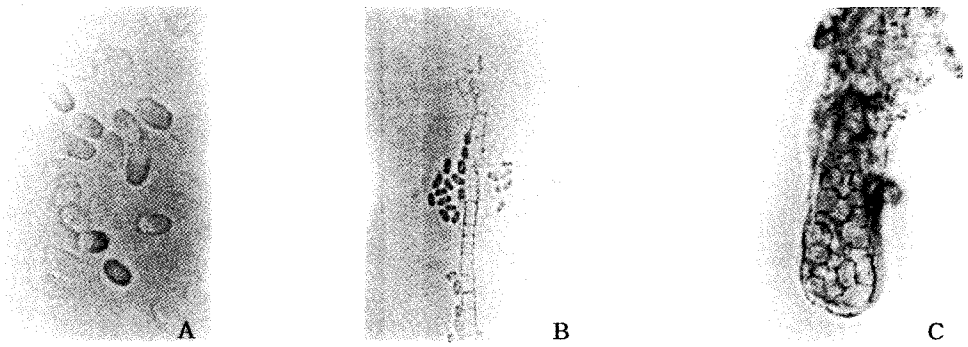


Fig. 3. *Dictyostelium macrocephalum.* A. Spores.(×1000). B. Tip.(×400). C. Base. (×400).

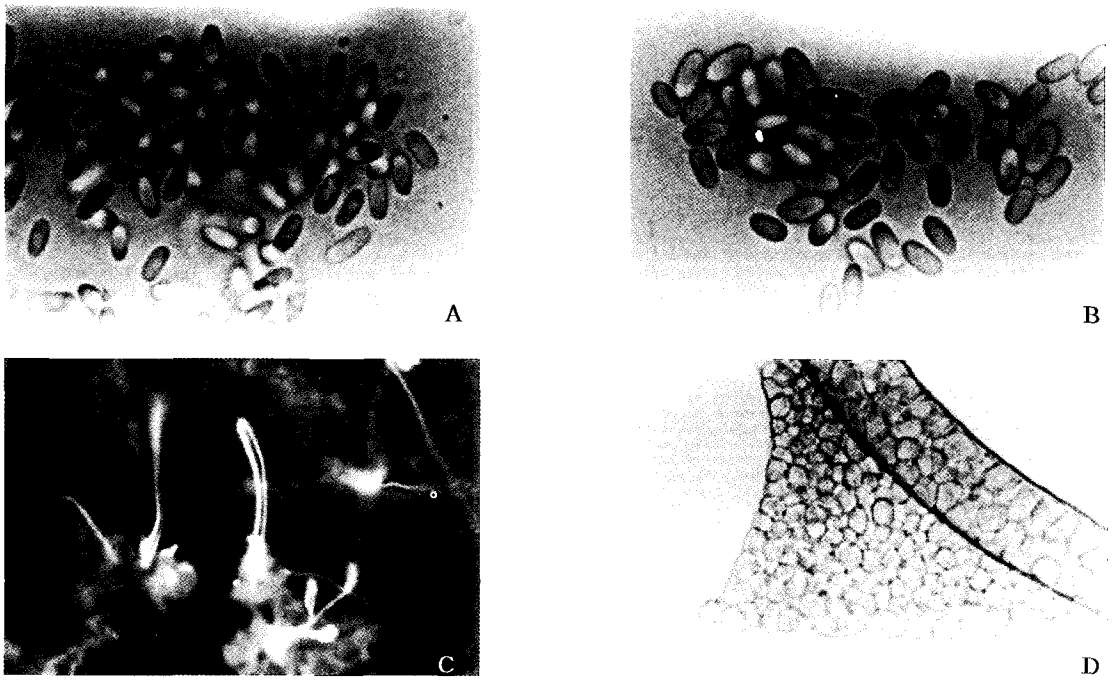


Fig. 4. *Dictyostelium purpureum.* A. Spores (temperate form) (×1000). B. Spores (subtropical form) (×1000). C. Young sorocarps (×30). D. Supporter (×400).

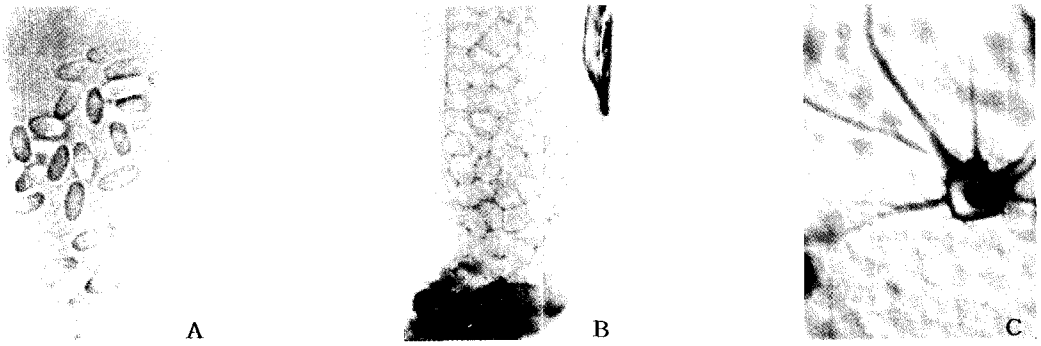


Fig. 5. *Dictyostelium robustum.* A. Spores (×1000). B. Base (×400). C. Pseudoplasmodium (×40).

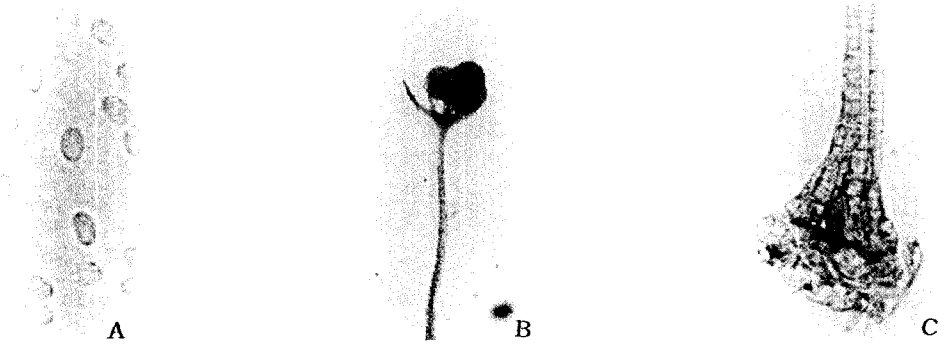


Fig. 6. *Dictyostelium polycephalum.* A. Spores (×1000). B. Coremium sorocarp (×100). C. Base (×400).

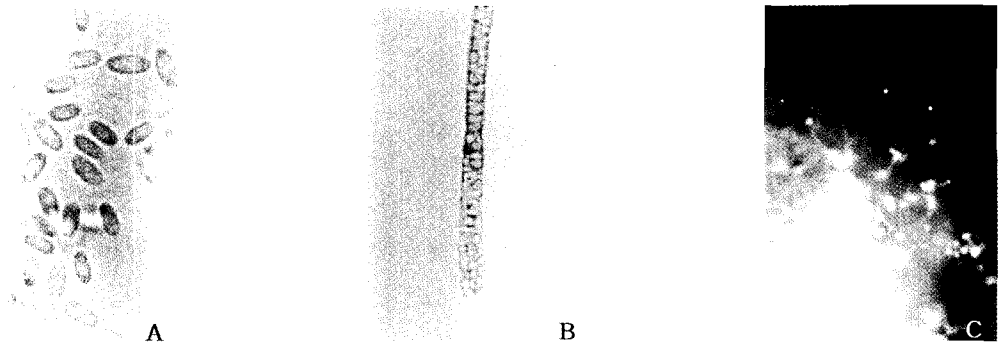


Fig. 7. *Polysphondylium violaceum.* A. Spores (×1000). B. Base (×400). C. Growth habit (×12.5).

with white sori (Hagiwara 1996). There were no polar granules in the elliptical spores. *D. robustum* and *D. firmibasis* were similiar, but they differed in that the former had longer sorophores with much thicker bases and somewhat larger spores. *D. polycephalum* (Fig. 6) had small clustered sorocarps developed in a coremium. The cluster of sorophores were represented by a thick stalk and several branches derived from its apex. Sorocarps of *P. violaceum* (Fig. 7) were usually gregarious, but often solitary. Sorophores were commonly light purple in color. The type of tips was clavate, and the type of bases was clavate to round. *D. minutum* (Fig. 8), *D. delicatum* (Fig. 9), *D. sp-1* (Fig. 10), and *D. sp-2* (Fig. 11) occurred only in the *Q. variabilis* community in Mt. Muhak. *D. sp-1* and *D. sp-2* are also being researched. *P. pallidum* complex is being identified.

Kanda and Sato (1985) researched the composi-

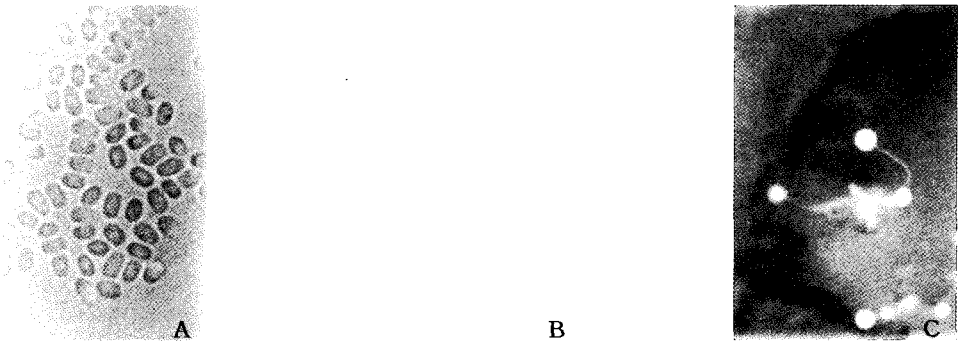


Fig. 8. *Dictystelium minutum*. A. Spores (×1000). B. Tip (×400). C. Sorocarps (×40).

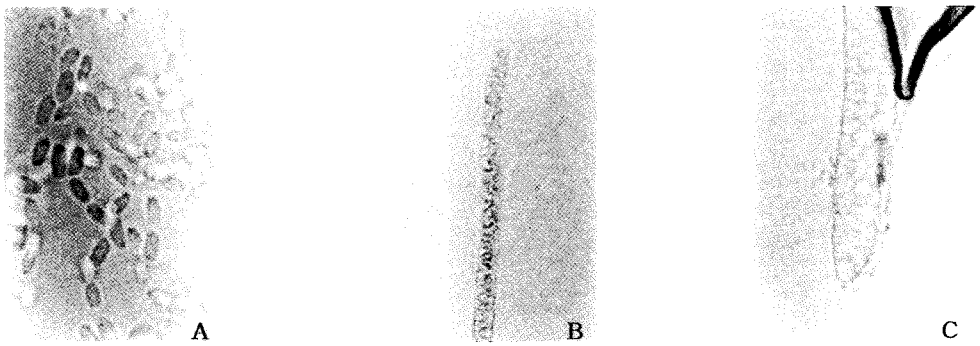


Fig. 9. *Dictystelium delicatum*. A. Spores (×1000). B. Tip (×400). C. Base (×400).

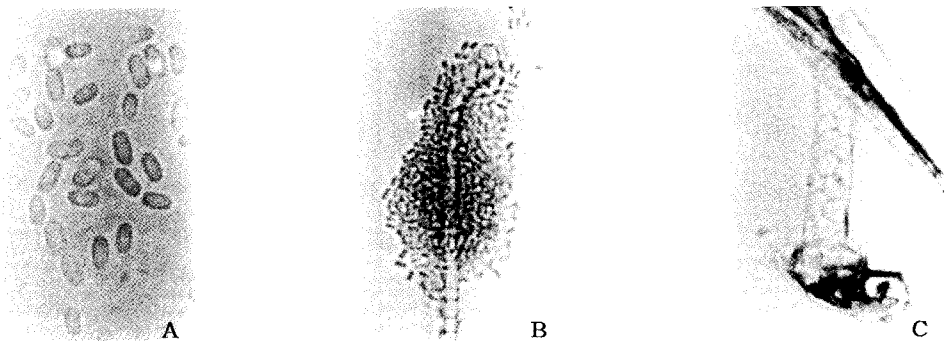


Fig. 10. *Dictyostelium sp-1*. A. Spores (×1000). B. Tip and spores (×400). C. Base (×400).

tion and density of Dictyostelid cellular slime molds in different plant communities found at various altitudes of Mt. Me-Akan in Hokkaido. Investgated sites were also separated by altitude. Five species, *D. mucoroides*, *D. minutum*, *D. lacteum*, *D. giganteum* and *P. violaceum*, were isolated from the soil samples of three at the lower altitude sites. According to Cavender (1969), forest soils in the tropics and subtropics of America have been shown to contain species of Acrasieae not found in temperate regions. *P. violaceum* was rare in forests of the humid tropical types in East Africa.

Benson and Mahoney (1977) studied about the distribution of Dictyostelid cellular slime molds in southern California with taxonomic notes on seleted species. *D. rosarium*, *D. mucoroides*, *D. sphaerocephalum*, and *D. minutum* were recored

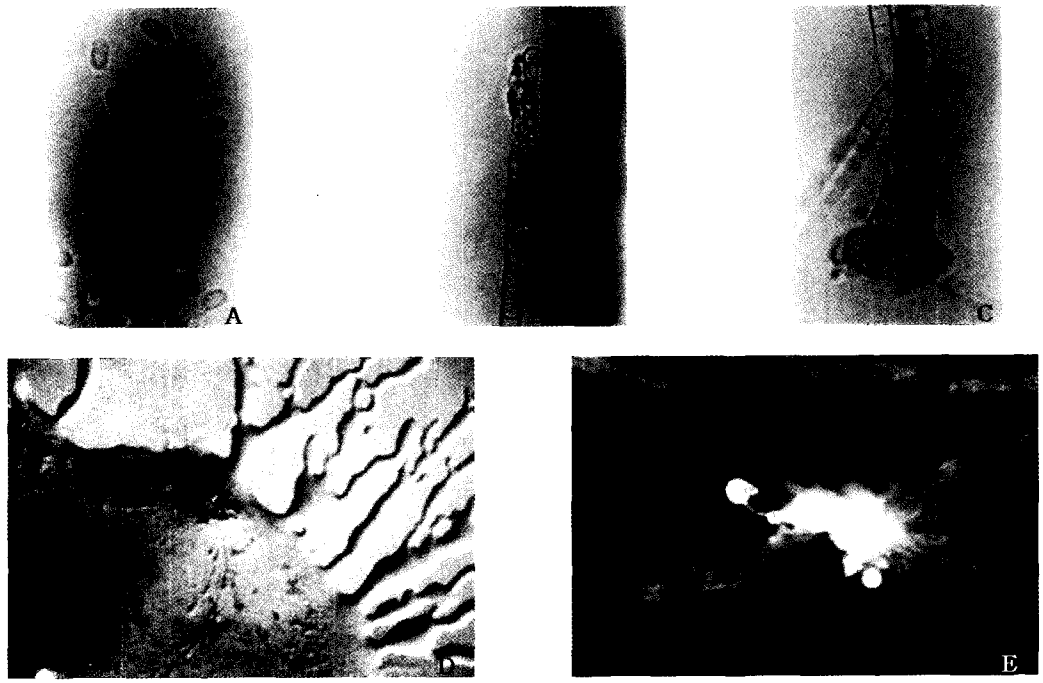


Fig. 11. *Dictyostelium sp-2.* A. Spores (×1000). B. Tip.×400. C. Base (×400). D. Pseudoplasmodia in early stage (×2.5). E. Clustered sorocarps (×25).

in lower montane coniferous forest. In mixed evergreen forest, *D. rosarium, D. mucoroides, D. sphaerocephalum, D. aureum,* and *P. pallidum* were represented.

Traub *et. al.* (1981) investigated the distribution of cellular slime molds in forest soils of Switzerland. According to the result, *Quercus pubescens* and *Q. robur-Castanea sativa* had *D. mucoroides, D. minutum, D. fasciculatum, D. giganteum, P. violaceum, P. pallidum,* and *P. filamentosum.*

Hong and Chang (1991) reported *D. mucoroides, D. minutum, D. mucoroides* variant, *D. purpureum, P. violaceum, P. pallidum,* and *D. polycephalum* in the coastal plant communities of islands near Inchon.

LITERATURE CITED

Benson, M.R. and D.P Mahoney. 1977. The distribution of dictyostelid cellular slime molds in southern California with taxonomic notes on selected species. Amer. J. Bot. 64: 496-503.

Bonner, J.T. 1967. The Cellular Slime Molds. Princeton Univ. Press, Princeton, New Jersey. 205 p.

Cavender, J.C. 1969. The occurrence and distribution of Acrasieae in forest soils. Ⅱ. East Africa. Amer. J. Bot. 56: 993-998.

Cavender, J.C. and K.B. Raper. 1965a. The Acrasieae in nature. Ⅰ. Isolation. Amer. Jour. Bot. 52: 294-296.

Cavender, J.C. and K.B. Raper. 1965b. The Acrasieae in nature. Ⅱ. Forest soil as a primary habitat. Amer. Jour. Bot. 52: 297-302.

Cavender, J.C. and K.B. Raper. 1965c. The Acrasieae in nature. Ⅲ. Occurrence and distribution in forests of easten North America. Amer. Jour. Bot. 52: 302-308.

Cavender, J.C., J. Cavender-Bares and H.R. Hohl. 1995. Ecological distribution of cellular slime molds in forest soils of Germany. Bot. Helv. 105: 199-219.

Kanda, F. and K. Sato. 1985. The composition and density of dictyostelid cellular slime molds in different plant communities found at various altitudes of Mt. Me-Akan, Hokkaido. Journal of Hokkaido University of Education (Section Ⅱ B) 36: 41-45.

Hagiwara, H. 1971. The Acrasiales in Japan. Ⅰ. Bull. Nat. Sci. Mus., Tokyo, Ser. B 14: 351-366.

Hagiwara, H. 1973. The Acrasiales in Japan. Ⅱ. Rept. Tottori Mycol. Inst. (Japan) 10: 591-595.

Hagiwara, H. 1974. The Acrasiales in Japan. Ⅲ. On two species of the Dictyosteliaceae from the Yaeyama Islands, Okinawa. Mem. Natn. Sci. Mus., Tokyo 7: 81-85.

Hagiwara, H. 1978. The Acrasiales in Japan IV. Bull. Nat. Sci. Mus., Tokyo, Ser. B 4: 27-32.

Hagiwara, H. 1979. The Acrasiales in Japan V. Bull. Nat. Sci. Mus., Tokyo, Ser. B 5: 68-72.

Hagiwara, H. 1983. The Acrasiales in Japan VI. Bull. Nat. Sci. Mus., Tokyo, Ser. B 9: 45-49.

Hagiwara, H. 1984a. Review of *Dictyostelium mucoroides* Brefeld and *D. sphaerocephalum* (Oud.) Sacc. et March. Bull. Nat. Sci. Mus., Tokyo, Ser. B

10: 27-41.
Hagiwara, H. 1984b. The Acrasiales in Japan. Ⅶ. Two new species, *Dictyostelium implicatum* and *D. crassicaule*. Bull. Nat. Sci. Mus., Tokyo, Ser. B 10: 63-71.
Hagiwara, H. 1984c, The Acrasiales in Japan. Ⅷ. *Dictyostelium septentrionalis* Cavender and *D. aureo-stipes* Cavender. Raper et Norberg. Bull. Nat. Sci. Mus., Tokyo, Ser. B 10: 159-167.
Hagiwara, H. 1984d. The Acrasiales in Japan. IX. A new species of *Dictyostelium* with small spores. Bull. Nat. Sci. Mus., Tokyo, Ser. B 12: 99-105.
Hagiwara, H. 1985. *Dictyostelium macrocephalum*, a new dictyostelid cellular slime mold from Taiwan. Bull. Nat. Sci. Mus., Tokyo, Ser. B 11: 103-108.
Hagiwara, H. 1989. The Taxonomic Study of Japanese Dictyostelid Cellular Slime Molds, National Sci. Mus., Tokyo. 131 p.
Hagiwara, H. 1992. Two forms of *Dictyostelium purpureum* Olive in Japan. Bull. Nat. Sci. Mus., Tokyo, Ser. B 18: 7-15.
Hagiwara, H. 1996. Dictyostelid in Japan. X. Two new species of *Dictyostelium*, *D. pseudo-brefeldianum* and *D. robustum*. Bull. Nat. Sci. Mus., Tokyo, Ser. B 22: 47-54.
Hong, J.S. and N.K. Chang. 1990. The occurence and distribution of cellular slime molds in major deciduous forests of South Korea. Korean J. Ecol. 33: 159-168.
Hong, J.S. and N.K. Chang. 1991. Occurence and distribution of cellular slime molds in relation to the coastal plant communities of islands near Inch'on. Korean J. Ecol. 14: 457-467.
Kuserk, F.T. 1980. The relationship between cellular slime molds and bacteria in forest soil. Ecology 61: 1474-1485.
McQueen, D.J. 1971. A components study of competition in two cellular slime mold species : *Dictyostelium discoideum* and *Polysphondylium pallidum*. Can. J. Zool. 49: 1163-1177.
Piaggio, M.J. 1989. Distribution of dictyostelid cellular slime molds in two grazing land soils in Uruguay. Mycol. 10: 173-178.
Raper, K.B. 1932. The distribution of *Dictyostelium* and other slime molds in soil, Journal of the Washington Academy of Science 22: 92-96.
Raper, K.B. 1984. The Dictyostelids. Prinston Univ. Press. Princeton, New Jersey. 453p.
Singh, B.N. 1947. Studies on soil Acrasiae: I. Distribution of species of *Dictyostelium* in soils of Great Britain and the effect of bacteria on their development. J. Gen. Microbiol. 1: 11-21.
Traub, F., H.R. Hohl and J.C. Cavender. 1981. Cellular slime molds of Switzerland. Ⅱ. Distribution in forest soils. Amer. J. Bot. 68: 172-182.

(*Received May 30, 2000*)