Aquatic Fungi of Iraq: Species of *Dictyuchus* and *Calyptralegnia*

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Summary. Taxonomy of the genera, *Dictyuchus* and *Calyptralegnia* is reviewed and a key has been composed for the better known species. Four species recorded from Iraq (*D. monosporus*, *D. pseudoachlyoides*, *D. carpophorus* and *C. ripariensis*) have been described and illustrated. Monthly isolations from the Shatt Al-Arab estuary from Sept., 1976 to Aug., 1977 have revealed that species of *Dictyuchus* occur throughout the year but are more abundant during spring and autumn, while *C. ripariensis* occurs only during the winter months.

Introduction

Both *Dictyuchus* and *Calyptralegnia* belong to the family Saprolegniaceae (Oomycetes). The former is represented by six good species while the latter is known only by two species. They grow saprophytically on dead organic matter although some species of *Dictyuchus* are known to be parasitic on fish and fish eggs. We have also observed that *D. monosporus* causes damping off of rice seedlings in Basrah area and germination of seeds is retarded and germlings grow slow (and very often killed) if these are artificially inoculated with the fungus.

This study is based on monthly samples obtained from the Shatt Al-Arab estuary from Sept., 1976 to Aug., 1977. This estuary is formed by the confluence of the rivers, Tigris and Euphrates near Qurna, flows southwards and drains into the Gulf. There are date-palm plantations on either side of the Shatt Al-Arab and these are irrigated by special channels which transport water at high tide. These channels have a rich growth of algae and other aquatic plants and these greatly contribute to the fertility of waters of Shatt Al-Arab (Kell and Saad, 1975).

Material and Methods

The methods of study followed are the same as discussed by Muhsin et al. (1978). Water samples were taken at monthly intervals from four different stations (Qurna, Ashar, Abul-Khasib and Khora) from Sept., 1976 to Aug., 1977. The samples were baited with boiled hemp seeds. The colonized baits were washed in sterile distilled water

and transferred to sterilized petridishes containing distilled water to which chloramphenicol, 35 μg/ml, had been added. The colonized baits were incubated at 22° C. The cultures were made unifungal by dissecting out hyphal segments and plating them on corn-meal agar. As soon as growth became evident (generally after 4—5 days) a block of agar was cut and placed in a petridish containing sterile distilled water. One boiled hemp seed was then placed near the agar block to serve as a bait.

Dictyuchus LEITGEB 1869

Type: *Dictyuchus monosporus* LEITGEB
Jahrb. für Wiss. Bot. 7: 358—59.

Mycelium usually sparse, or occasionally dense. Zoosporangia subfusiform to cylindrical, usually arising in a zig-zag sympodium, sometimes the zoosporangia detach or fall away and float freely. Zoospores not escaping from the zoosporangium but encysting within and forming a net-work of walls, the secondary zoospores emerging to the outside through individual openings in the wall of the zoosporangium. Gemmae absent or rarely may be present. Oogonia spherical, smooth, unpitted, usually with a single oospore. Antheridial branches diclinous, monoclinous or androgynous or sometimes absent.

The chief generic features are the nature of zoosporangia and predominantly single-spored oogonia. The primary zoospores encyst within the zoosporangium and form a persistent net-work (true-net type) and secondary zoospores escape through indivisual openings in the zoosporangial wall. In some staling cultures even secondary zoospores are not released but they germinate in situ and produce long germ tubes through the openings in the zoosporangial wall. In some species the secondary zoospores do not escape but the wall of the zoosporangium disintegrates or gelatinises thus freeing the encysted primary zoospores (false-net type). In some species, however, some of the zoosporangia may disintegrate in an achlyoid fashion (primary zoospores escaping through the apical opening and encysting at the mouth forming a hollow sphere). There is a strong tendency among zoosporangia to detach from the supporting hyphae and float freely. This adaptation perhaps helps them in dispersal. All the known species have a single oospore in each oogonium which occupies a greater part of the cavity. The oospores may be centric or eccentric. The antheridia are absent in some species but when present they may be diclinous to monoclinous or androgynous. The specific limits of the species under this genus are not clearly demarcated and there seems no agreement over the validity of different species or their synonymy. In view of it a key has been composed for the better known species (DICK, 1973: JOHNSON, 1974).

Key to the Species

A. Antheridial branches absent . . . . . B
A. Antheridial branches present C

B. Zoosporangia of true- net type . . . . . *D. anomalus*
B. Zoosporangia of false-net type. . . . . *D. missouriensis*
C. Antheridial branches androgynous or monoclinous . . . . . D
C. Antheridial branches always diclinous; oogonium usually 25 (35) μm in diameter. . . . . *D. monosporus* (= *D. magnusii*)
D. Oospores centric; oogonia pendent and comparatively large in size, 37—42 μm in diameter. . . . . *D. pseudoachlyoides*
D. Oospores eccentric; oogonia not pendent and comparatively smaller in size . . . . . E
E. Zoosporangia predominantly true-net type of false-net type, not or very rarely achlya-type . . . . *D. carpophorus* (= *D. pseudodictyon*)
E. Zoosporangia predominantly achyatype . . . . . *D. achlyoides*

Dictyuchus pseudoachlyoides Beneke 1948. — Figs. 4—5.
J. Elisha Mitchell Sci. Soc. 64: 263.

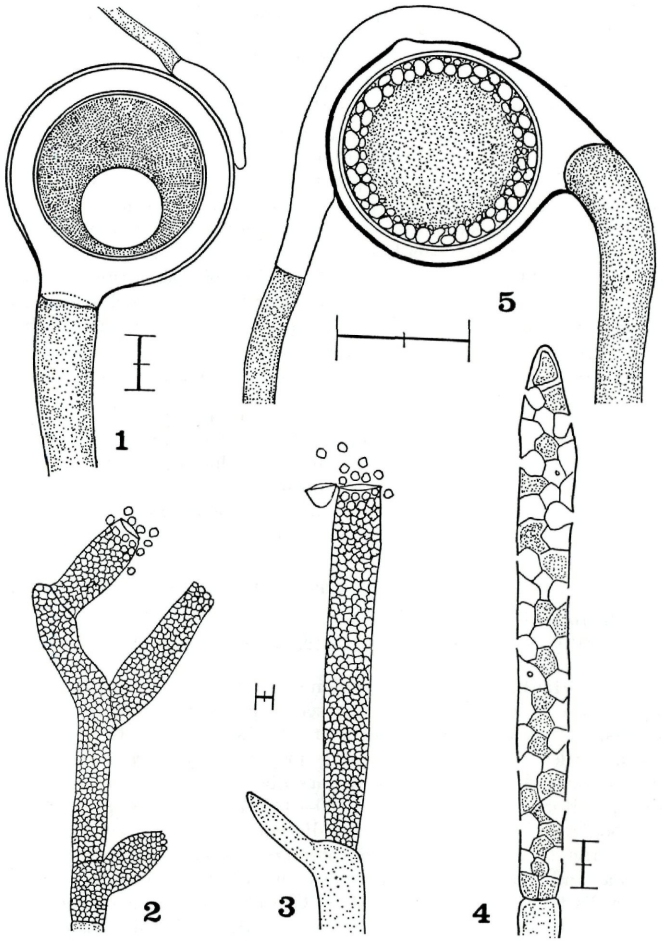
Mycelium usually sparse, 4-week old colonies on hemp seeds 1.5 cm in diameter; primary hyphae 30—90 μm wide at the base, thin-walled, sparsely branched, usually becoming narrow and thin-walled towards the apices. Gemmae absent. Zoosporangia abudant, subcylindrical to occasionally fusiform, 200—900×14—28 μm, renewed sympodially forming false axis; zoospore discharge dictyoid leaving a true-net type sporangium; zoosporangia often detach from the supporting hyphae and float freely; zoospore cysts 9—11 μm in diameter, globose to angular (in the zoosporangium) due to the mutual pressure, the walls thin, smooth, subhyaline. Oogonia less common, lateral, spherical, often pendent, 28—40 μm in diameter, the walls thin (1—2 μm thick), smooth, not pitted; oogonial stalk usually curved near the apex, cylindrical, thin-walled, rarely more than twice the diameter of oogonia. Oospores single in each oogonium and usually filling the cavity, 24—31 μm in diameter, centric, spherical, smooth, thin-walled. Antheridial branches monoclinous to androgynous, often branched and coiling around the oogonia, persistent, thin-walled; antheridial cells tubular to clavate, laterally appressed.

Collections Examined: Ashar, Basrah, Jan., 1977, TMM 472; Abul-Khasib, Basrah, Feb., 1977, TMM 493.

This species is marked by androgynous to monoclinous antheridal branches and centric oospores. Johnson (1956) has recorded that oogonia are larger in size than reported in the type and that they are pendent.

Dictyuchus carpophorus Zopf 1893. — Figs. 6—7.
Beiträge Physiol. Morphol. Niederer Org. 3: 48.
= *Dictyuchus pseudodictyon* Coker & Braxton 1926, Journ. Elisha Mitchell Sci. Soc. 42: 144.

Mycelium usually dense, 3-week old colonies on hemp seeds up to 1 cm in diameter; primary hyphae 15—40 μm wide at the base,



Figs. 1 – 5. *Calyptralegnia riparіensis* (1–3), 1, oogonium with eccentric oospores; 2, 3, zoosprangia showing discharge of zoospores. *Dictyuchus pseudoachlyoides* (4–5), 4, zoosporangium true-net type; 5, oogonium with curved oogonial stalk. Scale, 20 μm

rarely more, thin-walled, branched, becoming progressively narrow and thin-walled towards the apcies. Gemmae absent. Zoosporangia abundant, fusiform to subcylindrical, 280—360×21—29 μm, renewed sympodially; zoospore discharge dictyoid, leaving a true-net type zoosporangium; rarely aplanoid; zoospore cysts 9—12 μm in diameter, globose to somewhat angular (in the zoosporangium) due to mutual pressure, the walls thin, smooth, subhyaline. Oogonia abundant, lateral, spherical, 30—43 μm in diameter, the walls smooth, thin, not pitted or rarely pitted at the point of contact with the antheridia; oogonial stalk short to occasionally long, sometimes may be up to 360 μm long but commonly less than twice the diameter of oogonia. Oospores single and usually occupying a greater part of the oogonial cavity, 24—29 μm in diameter, eccentric, spherical, smooth, thin-walled. Antheridial branches androgynous to monoclinous, often branched and coiling around oogonia, persistent, thin-walled; antheridial cells tubular, laterally or apically appressed.

Collection examined: Qurna, Basrah, March, 1977, TMM 533.

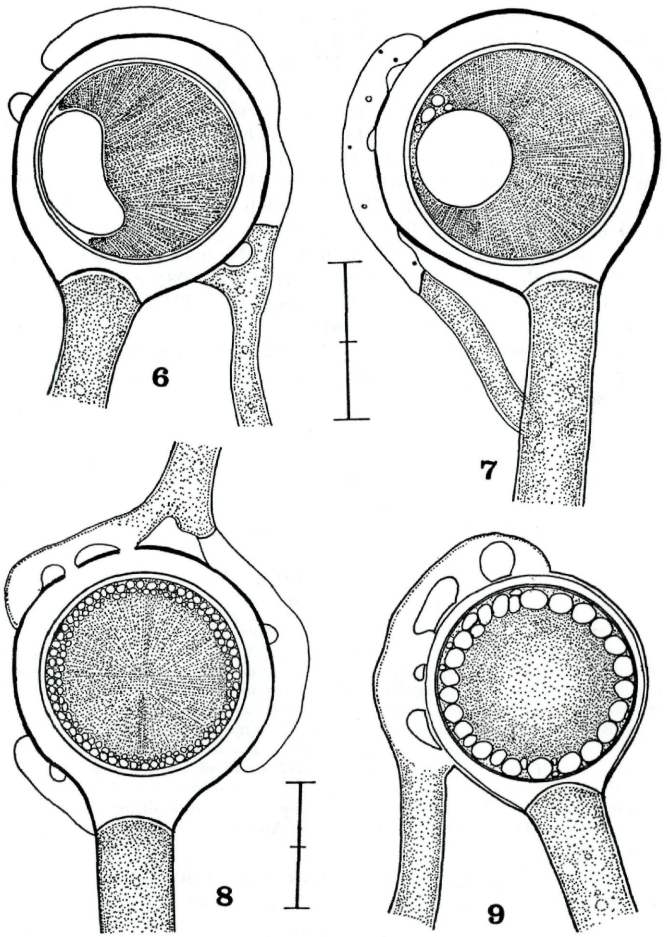
This species is marked by the predominantly androgynous to monoclinous antheridial branches and eccentric oospores. *D. pseudoachlyoides* seems very close but differs in having relatively wider hyphae, larger oogonia and centric oospores. The antheridial branches are predominantly androgynous in *D. carpophorus* but these are predominantly monoclinous to androgynous in *D. pseudoachlyoides*.

Dictyuchus monosporus Leitgeb 1869. — Figs. 8—9.

Jahrb. Wiss. Bot. 7: 357.

= *Dictyuchus magnusii* Lindst. 1872, Synopsis de Saprol., p. 7.

Mycelium usually dense, colonies 1—1.5 cm in diameter (rarely up to 2.5 cm) in 4 weeks on hemp seeds; primary hyphae 15—45 μm (occasionally up to 85 μm) in diameter at the base, thin to moderately thick walled, branched, becoming pregressively narrow and thin-walled towards the apices. Gemmae absent. Zoosporangia abundant, fusiform to subcylindrical, 150—450 (700)×15—30 μm, renewed sympodially; zoospore discharge dictyoid leaving a true-net type zoosporangium. Occasionally zoosporangia detach from the supporting hyphae and float freely; zoospore cysts 9—13 μm in diameter, globose, the walls thin, smooth, subhyaline. Oogonia common to abundant, lateral, spherical, 30—40 μm in diameter, the walls thin, smooth, not pitted or rarely with pits at the point of contact with antheridia; oogonial stalk straight, cylindrical, 25—60×10—15 (20) μm, thin-walled. Oospores single and usually filling the cavity, 25—30 (35) μm in diameter, centric, spherical, smooth, thin-walled. *Antheridial* branches diclinous, filiform, 7—14 μm wide, branched, thinwalled,



Figs. 6—9. *Dictyuchus carpophorus* (6—7), oogonia each with a single eccentric oospore. *Dictyuchus monosporus* (8—9), oogonia each with a single centric oospore. Scale, 20 μm

persistent, antheridial cells tubular to rarely clavate, laterally appressed and often extensively coiling around oogonia.

Collections examined: Qurna, Basrah, Sept., 1976, TMM 300; Ashar, Basrah, Sept., 1976, TMM 301; Ashar, Basrah, Oct., 1976, TMM 321; TMM 322; TMM 323; TMM 324; Khora, Basrah, Oct., 1976, TMM 325; Ashar, Basrah, Nov., 1976, TMM 357; TMM 358; Khora, Basrah, Nov., 1976, TMM 359; Qurna, Basrah, Jan., 1977, TMM 437; Ashar, Basrah, Jan., 1977, TMM 438; Khora, Basrah, Jan., 1977, TMM 439; TMM 440; TMM 441; Qurna, Basrah, Feb., 1977, TMM 491; TMM 492; Abul-Khasib, Basrah, March, 1977, TMM 531; TMM 532; Ashar, Basrah, April, 1977, TMM 560; Khora, Basrah, April, 1977, TMM 561; Abul-Khasib, Basrah, April, 1977, TMM 562; TMM 563; Ashar, Basrah, May, 1977, TMM 604; TMM 605; TMM 606; Abul-khasib, Basrah, May, 1977, TMM 607; TMM 608; Ashar, Basrah, June, 1977, TMM 639; Qurna, Basrah, Aug., 1977, TMM 669; TMM 670; Ashar, Basrah, Aug., 1977, TMM 671.

This species appears to be very common throughout the year and is marked by the diclinous antheridial branches, large oogonia and centric oospores.

Dictyuchus sp. (nonsexual isolates)

Thirty six isolates of *Dictyuchus* failed to produce oogonia and remained sterile. Consequently, it was not possible to give them specific names. The monthly record of these is shown in table 1.

Calyptralegnia Coker 1927

Journ. Elisha Mitchell Sci. Soc. 42: 219.

Hyphae stout, sparsely to moderately branched, broader at the base but become progressively narrow towards the apices. Gemmae absent. Zoosporangia usually cylindrical to hyphoid or less commonly clavate to naviculate, terminal or intercalary, renewed basipetally. Zoospores dimorphic; primary zoospores encysting within the zoosporangium, encysted zoospores appear angular and tight fitted. Zoosporangium dehiscence by the separation of an apical segment or lid (operculum). Zoospore cysts become apically loosened from spore mass, protrude out of the zoosporangial mouth and are dispersed by water currents. Secondary zoospores emerge out of the cysts soon after their release. Oogonia terminal or lateral, the walls smooth, unpitted; oogonial stalk present, usually short. Oospores 1—8, subcentric or eccentric. Antheridial branches androgynous to monoclinous or diclinous.

Type: *Calyptralegnia achlyoides* (Coker & Couch) Coker

The chief generic features are the presence of an operculum of lid at the apex of zoosporangium and the manner of discharge of zoospores. The oospore number varies from 1—8 and these are usually more than 45 μm in diameter. This monotypic genus was proposed by Coker (1927) to accomodate a single species but another species was later on added by Hohnk (1953).

Key to the Species

A. Oospores subcentric; zoosporangia mostly terminal, rarely intercalary; antheridia androgynous to monoclinous, rarely diclinous. . . . . *C. achlyoides*

A. Oospores eccentric; zoosporangia mostly intercalary and less commonly terminal; antheridia usually diclinous. . . *C. ripariensis*

Calyptralegnia ripariensis Hohnk 1953. — Figs. 1—3.
Veröff. Inst. Meeresforsch., Bremerhaven 2: 232.

Mycelium usually dense, 4-week old colonies on hemp seeds 1.5—2 cm in diameter; primary hyphae (30) 50—85 (116) µm wide at the base, sparsely branched but branches become more profuse towards the periphery, thin-walled, comparatively stout. Gemmae absent. Zoosporangia abundant, cylindrical to hyphoid, (145) 225—560 (1050)×40—60 (95) µm, terminal but more commonly intercalary, renewed basipetally; zoosporangial dehiscence by an apical lid or operculum; primary zoospores encysting within the zoosporangium, cysts crowded and appear angular, these escape in groups apically by swelling. The escaping cysts become loose from the main mass of cysts, protrude out of the zoosporangial mass and are easily dispersed by water currents. Secondary zoospores emerge out of the cysts soon after their release. Oogonia abundant, lateral or terminal, globose to subglobose, 58—130 µm (normally 60—85 µm) in diameter, the walls smooth, unpitted; oogonial stalk 22—210 µm long and 14—24 µm wide, straight to slightly bent. Oospores eccentric, 1—5 (8) per oogonium, usually filling the oogonial cavity, spherical, 40—60 µm in diameter, smooth, germination not seen. Antheridial branches diclinous, sparsely branched, 7—11 µm wide; antheridial cells tubular to clavate, laterally appressed.

Collections examined: Qurna, Basrah, Dec., 1976, TMM 409; Ashar, Basrah, Dec., 1976, TMM 410; Qurna, Basrah, Jan., 1977, TMM 474; TMM 475; TMM 476; Ashar, Basrah, Jan., 1977, TMM 477; TMM 478.

This species is marked by the eccentric oospores, predominantly diclinous antheridial branches and intercalary zoosporangia.

Calyptralegnia sp. (nonsexual isolates)

Three isolates of *Calyptralegnia* failed to produce oogonia in culture and hence could not be determined up to specific level. Since only one species of *Calyptralegnia* is known from the area so perhaps these isolates belong to this species. Their monthly record is given in table 1.

Table 1. Monthly distribution of isolates of various species of *Dictyuchus* and *Calyptralegnia*, temperature, salinity, pH and dissolved oxygen from September, 1976 to August, 1977

Name of month	Temperature in °C	pH value	Dissolved oxygen ppm	Salinity ‰	*C riparienesis*	*Calyptralegnia* sp. non-sexual	*D. pseudoachlyoides*	*D. carpophorus*	*D. monosporus*	*Dictyuchus* sp. non-sexual
Sept. '76	26—27	7—7.6	6.8—7.2	0.33—0.83					2	
Oct. '76	24—25	7—7.6	6.5—7.1	0.57—0.85					5	6
Nov. '76	19—20	7.3—7.6	7.4—8.3	0.22—0.69					3	5
Dec. '76	14—16	7.0—7.4	7.8—8.1	0.15—0.49	2	3				3
Jan. '77	11—12	6.7—7.0	8.2—9.2	0.12—0.40	5		1		5	
Feb. '77	16	6.7—7.3	7.9—8.5	0.23—0.47			1		2	1
Mar. '77	20—21	6.9—7.3	6.8—7.7	0.30—0.68				1	2	4
Apr. '77	20—21	7.0—7.4	7.6—7.9	0.13—0.60					4	5
May '77	27	7.4—7.6	6.3—7.3	0.25—0.76					5	6
June '77	28	7.5—7.8	6—6.3	0.52—1.05					1	2
July '77	31—32	7.8—8.2	5.8—6.2	0.69—1.31						2
Aug. '77	30	7.4—7.6	6.5—7.4	0.44—0.90					3	2

Discussion

The data in table 1 shows that the species of *Dictyuchus* occur throughout the year but seem to grow best at moderate temperatures (19—27° C) in spring and autumn. However, there appears a decline in their numbers at higher temperatures (June—August) and also at lower temperatures (December—February). It is interesting to observe that formation of oogonia (sexually maturity) is more pronounced during winter months while the number of nonsexual isolates increases with the rise in temperature. The isolates of *Calyptralegnia* are very few and it is difficult to make any generalized statement. Nevertheless, the data at hand show that they occur only during the winter months.

The range of pH is rather narrow although it is mostly on the alkaline side. The species of *Dictyuchus* show maximum growth between the range of 7 and 7.6. The water of Shatt Al-Arab are well saturated with dissolved oxygen and it does not seem to be a limiting factor for growth of these fungi. The range of salinity is also low and does not seem to effect the growth of *Dictyuchus* and *Calyptralegnia*.

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