

Studies on Dermocystidiosis (Yellow Muscle Disease) among Some Marine Fishes of Arabian Gulf and Red Sea Coast, Jeddah, Saudi Arabia

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Abstract: About one year period from December, 2011 to November, 2012 freshly caught marine fish from the coast of Arabian Gulf at Qatef, Eastern province and Red Sea coast, Jeddah of Saudi Arabia were examined as a routine fish health survey for Dermocystidium infections. Altogether, 1500 specimens from 45 species at Qatef and 116 specimens of grouper *Epinephelus polyphekadion* at Jeddah were sampled. The prevalence of Dermocystidiosis in Qatef was 7.66% while prevalence in Jeddah was 18.96 %. The following fish species were infected with Dermocystidiosis at the given prevalence; *Johinus maculatus* (37.5 %) *Lethrinus nebulosus* (11.53 %), *Lutjanus ehrenbergi* (28.75 %), *Lutjanus malabaricus* (22.5 %) & *Cephalopholis hemistiktos* (20%) at Qatef while one species *Epinephelus polyphekadion* (18.96 %) only infested at Jeddah. *Lutjanus ehrenbergi* & *Lutjanus malabaricus* showed low intensity of infestation. *Johinus maculatus* & *Cephalopholis hemistiktos* with medium intensity of infestation and appeared to be perfectly normal, while *Lethrinus nebulosus* was highest intensity of infestation and showed detached scales, dull opaque body color with turbidity on various parts of the body and emaciation with sunken belly. Diseased fish showed grossly visible yellow blotches or spots within the musculature at sections cut from musculature of fishes suspected infection with Dermocystidiosis. Fresh sample preparations and histopathological examination for gills and musculature of naturally infected fish, revealed various spore stages of a new Dermocystidium species, it established as *D. Arabica* sp. n. Scan Electron Microscope (SEM) was carried out for isolated hyphae and spores to confirm the diagnosis in this study, because of the yellow color of the muscle was a characteristic sign for the all infected fish and the available articles not previously dealt with this phenomenon, the disease is suggested to be named as "Yellow Muscle Disease".

Key words: Arabian Gulf • Jeddah • *Dermocystidium Arabica* sp. N • Yellow Blotches • SEM • Yellow Muscle Disease.

INTRODUCTION

Dermocystidium has been described as a parasitic genus since early this century. There has been considerable argument as to whether the organism is in fact protozoa or fungi [1, 2]. The organisms have often been relegated to unspecified groups of lower fungi and formation of hyphae in *D. koi* has been suggested as evidence of the possible fungal nature of this parasite. *D. salmonis* has recently been placed in the new Class

Ichthyosporea (Now Mesomycetozoa) within the Subphylum Choanozoa (Phylum Neomonada) in the Kingdom Protozoa [3]. Lom and Dykova [1] defined the description of the genus *Dermocystidium*, dividing the known species into three groups according to their morphology and types of infection. At that time, about 20 species were known, mostly thanks to light microscope observation. Knowledge of the life cycle was incomplete and their phylogenetic position was enigmatic [4].

Severe gill pathology and mortality have been reported in prespawning adults and emergent fry of Chinook salmon in the USA [5, 6]. Heavy gill infections of *Dermocystidium* infection have been reported by Spangenberg [7] to result in reduced growth in eels, *Anguilla anguilla*, but, in contrast, Wootten and McVicar [8] found no evidence of major effects with a *Dermocystidium* infection, again of gills of eels, reared in a recirculation system.

The species infecting fish locate either in epithelial tissue of the skin, fins and gills or in visceral organs. The infections often appear as small round, oval or elongate white nodules or cysts in the affected tissue [4, 9-11]. The diagnostic feature is the presence of a spherical stage (spores), having a large central inclusion body (Signet-ring stage); Höglund *et al.* [12]. There have been a few cases of visceral and systemic infections in salmonid fish by an intracellular parasite identified as a *Dermocystidium species*. It was found mainly in the visceral cavity [13], or in melanomacrophages [14], or it induced systemic infections [15, 16]. So, this is a first report on this organism from the musculatures of five marine fish, *Johinus maculatus*, *Lethrinus nebulosus*, *Lutjanus ehrenbergi*, *Lutjanus malabaricus* and *Cephalopholis hemistiktos* from Arabian Gulf.

No previous records on *Dermocystidium* in marine fish from Saudi Arabia; Arabian Gulf and Jeddah coast. Therefore, the present study was designed to throw the light on *Dermocystidium* sp. which infest some marine fish species at the Eastern province at Qatef and Jeddah of Saudi Arabia, recording clinical and post mortem signs, prevalence, intensity of infestation, seasonal variation of the infestation, detect the size of the infected fish and investigate the histopathological alterations which may produced by these organism infestation.

MATERIALS AND METHODS

Collected Fish: During a routine fish health survey for freshly caught marine fish from Arabian Gulf at Qatef, Eastern Province and Jeddah of Saudi Arabia, at the period from December, 2011 to November, 2012, about 1500 specimens belonging to 45 species were freshly collected from different locations at Qatef and 116 grouper *Epinephelus polyphkadion* were freshly caught at Jeddah coast.

Fish samples were sorted according to species placed in plastic bags written the data on it then transported to the laboratory of Fisheries Research Center

Qatef and Jeddah in iced storage box. All fishes were measured to the nearest mm total length and weight was recorded to the nearest gm.

Light Microscope Examination: The fish was filleted and skinned, thick filets being sliced lengthwise. Yellow patches or streaks within flesh of the infected fish were easily recognized by naked eye. Gill arches of each fish was removed and examined macroscopically for *Dermocystidium* cysts. Macerated preparations from the infected muscle as well as from cyst or hyphal contents of infected gills were examined under light microscope for the presence of *Dermocystidium* spores and developmental stages. Other samples were fixed with methanol for staining with Giemsa stain [17].

Preparation of Samples for Scan Electron Microscope (SEM): Parts of hyphal-like cysts or streaks detected in the infected musculature were fixed in 4 % cold glutraldehyde, dehydrated, coated with gold and examined by SEM.

Fixation of specimens in 3% glutraldehyde in Sorensen's Phosphate Buffer, (pH 7.2), overnight. Wash specimens in 3 changes of Buffer. (5 min. each), then in H₂O. (5 min.). Immerse specimens in 2% OSO₄ for 2 hr, after that wash in 3 changes of H₂O. 5 min. each. Dehydrate using a series of ethanol. Critical Point Dry 2 hr. Mount specimen on a stub with silver paint, then coat with gold and lastly viewed in Hitachi S-1300 Scanning Electron Microscope (SEM), David and Joy [18].

Identification of *Dermocystidium*: The identification of *Dermocystidium* sp. was performed using clinical and post mortem lesions of the infected fishes, fresh and stained preparations, histological examination and SEM for the hyphal-like cysts and its content help in identification of the organism.

Histopathological Examination: Sections were taken from the affected musculature; gills, liver and spleen of diseased fish were fixed in 10% formal saline for twenty-four hours. Sections were washed in tap water and passed in serial dilutions of alcohol (Ethyl and absolute ethyl) for dehydration. Specimens were cleared in xylene and embedded in paraffin. Paraffin wax tissue blocks were prepared for sectioning at 5-7 microns thickness by sledge microtome. The obtained tissue sections were collected on glass slides, deparafinized, stained by hematoxylin and eosin and, periodic acid Schiff (PAS) then, examined using light electric microscope [19].

RESULTS

Clinical Signs and Post Mortem Lesions of the Diseased Fish:

The clinical picture of Dermocystidiosis varies considerably, since there are no uniform symptoms. Fish with light or moderate Dermocystidiosis showed no any clinical abnormalities and appeared to be perfectly normal. Detached scales, dull of color with turbidity on various parts of the body & emaciation with shrunken belly were observed in some cases of heavily infested fish of *Lethrinus nebulosus*. In postmortem examination, the main signs of disease were the appearance of yellow spots in the musculature of 5 fish species (*Johinus maculatus*, *Lethrinus nebulosus*, *Lutjanus ehrenbergi*, *Lutjanus malabaricus* and *Cephalopholis hemistiktos*). *Lethrinus nebulosus* with heavy infestation showed short brown sticks in their muscle. One fish species, only *Johinus maculatus* had yellow fusiform cysts in their gills.

While *Epinephelus polyphkadion* was observed had short white threads in between primary gill lamellae, the body surface opaque covered with blue mucous especially the upper surface with emaciation. The post mortem lesions of different examined fish species were demonstrated in (Figs. 1- 4).

Identification of Dermocystidium: The yellow spots consists of a web of yellow threads (Hyphae) (Diameter: Less than 0.1 mm) which easily seen in examined preparations of the infected musculature. Each thread (Hyphae) had unlimited numbers of spores of different developmental stages. The mature spores were spherical or oval in shape, variable in size 8.2 μm (6.4-10.3 μm) with a large central inclusion body (Signet-ring stage) which nearly fills the spore, surrounded by a thin rim of host cytoplasm (Fig. 5.C&D). Short brown sticks in the muscle of *Lethrinus nebulosus* as well as a yellow fusiform cyst in the gills of *Johinus maculatus* had the same spore that present in the yellow infected musculature or white short threads (Hyphae) in between the primary gill filaments in grouper *Epinephelus polyphkadion*. The spores were readily detected in Giemsa-stained imprints, where most spores appeared as slightly dark-stained oval or spherical bodies (Fig.5, A). Moreover, Histological examination revealed spores contained a prominent inclusion body, which gave a positive reaction for PAS (Fig.5.B) From clinical sings, post mortem lesions, histological examination and morphological characters recorded by light and scan electron microscope of the isolated hyphae & spores characters (Fig. 6) identified as *Dermocystidium Arabica sp. n.*

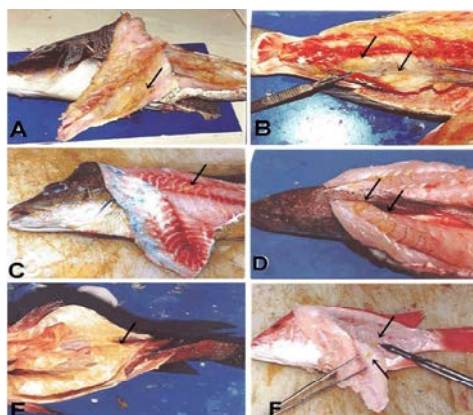


Fig. 1: Showing Dermocystidium hyphae (Threads) embedded in musculature of infested fish species in Qatef (A) *Lethrinus nebulosus* fish the yellow patches were observed deeply in the musculature that faced to the vertebral column. (B) *Lethrinus nebulosus* fish the yellow patches were observed in the entire muscles under the skin. Brown dots or sticks were also seen within the musculature (C) In *Lutjanus ehrenbergi*, small yellow patches area were observed in muscle layer under the skin. (D) In *Johinus maculatus*, the yellow threads were noticed only in the connective tissue between the muscle bundles of the dorsal region, (E) *Cephalopholis hemistiktos* had a web of yellow threads (Hyphae) in the abdominal muscles. (F) *Lutjanus malabaricus* fish, small yellow patches (Hyphae) were observed deeply in the musculature that faced to the vertebral column.

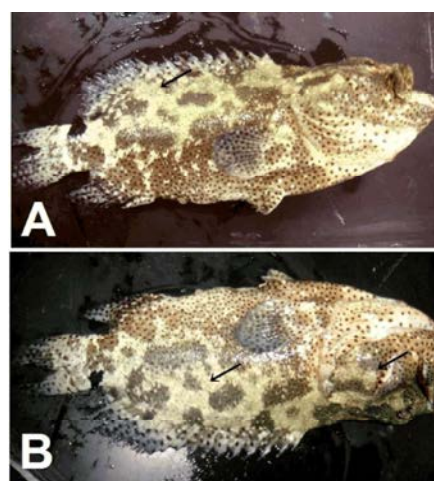


Fig. 2: Showing grouper, *Epinephelus polyphkadion* fish in Jeddah appearing with opaque surface covered with blue mucous especially at the upper surface with eroded caudal fins (Arrows)

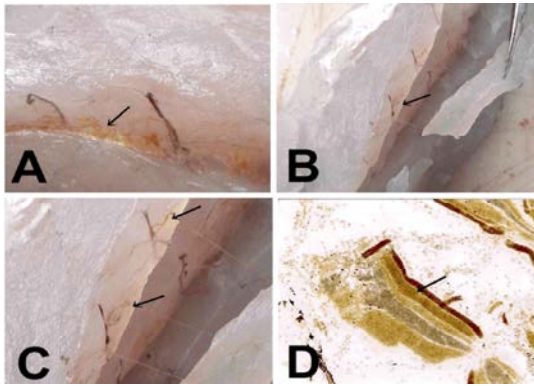


Fig. 3: Showing (A,B,C) In *Johinus maculatus*, The yellow spots consists of a large numbers of threads [filament or hyphal like structure] (Diameter: Less than 0.1 mm) which easily seen in the infected musculature (Arrows) (D) Fresh preparations from the infected musculature revealed lots of spores of different developmental stages (Arrows).

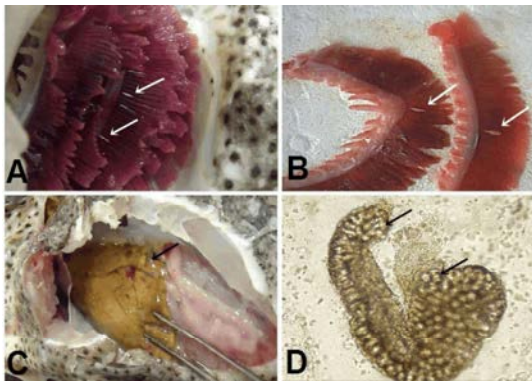


Fig. 4: Showing (A) Gills of grouper, *Epinephelus polyphkadion* with embedded short white threads (Hyphae) in between primary gill filaments (Arrows) (B) Yellow fusiform cyst in gills of *Johinus maculatus* (Arrows) (C) showing pale yellow fatty liver (Arrow) (D) wet mount preparation of hyphal threads contain large numbers of spores (Arrows).

Prevalence of Dermocystidiosis: The total prevalence of Dermocystidiosis among investigated fish at Qatuf was 7.66% while the prevalence in Jeddah was 18.98%. The total prevalence was 8.47% Table 1. The data indicates that highest incidence of infestation with *Dermocystidium Arabica* sp. n. was found in *Johinus maculatus* (37.50%) followed by *Lutjanus ehrenbergi* (28.75%) followed by *Lutjanus malabaricus* (22.50 %) followed by *Cephalopholis hemistiktos* (20.00%) followed by

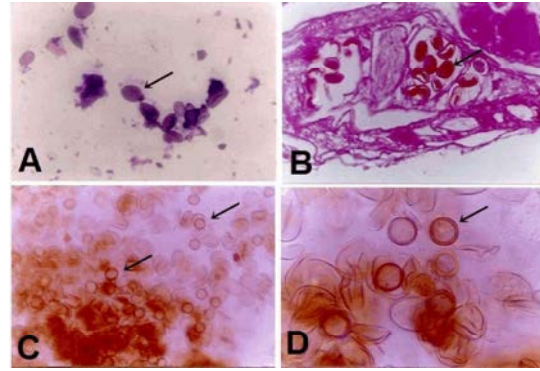


Fig. 5: Showing (A) Spores stained with Giemsa stain, a large inclusion body nearly fills the spore (Arrow) (B) The mature spore has a large, PAS [Periodic acid-Schiff stain] positive inclusion body surrounded by a thin rim of host cytoplasm (Arrow) (C.&D) Fresh preparation, the mature spores appeared spherical in shape, variable in size with a large inclusion body with a narrow rim of cytoplasm and internal wall of the central inclusion body is surrounded by thick membranous like-shape (Arrows).

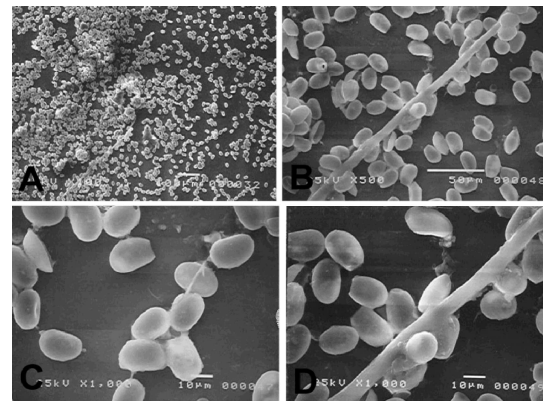


Fig. 6: (A&B&C&D) showing scan electron microscopy for hyphae as well as the spores of *Dermocystidium Arabica*

Table 1: Incidence of infection with *Dermocystidium Arabica* in investigated marine fish in Qatuf and Jeddah

Location samples of examined fish	No of examined fish	No. of infected fish	% of infestation
Qatuf	1500	115	7.66
Jeddah	116	22	18.96
Total	1616	137	8.47

Epinephelus polyphkadion (18.96%) and lowest prevalence was for *Lethrinus nebulosus* (11.53 %) Table 2.

Table 2: Prevalence of *Dermocystidium Arabica* in investigated marine fish species

Species	Length (cm)	No. Exam.	No. Infect.	%
<i>Johinus maculatus</i>	23 - 68	120	45	37.50
<i>Lethrinus nebulosus</i>	23 - 74	260	30	11.53
<i>Lutjanus ehrenbergi</i>	15 - 35	80	23	28.75
<i>Lutjanus malabaricus</i>	25 - 58	45	10	22.50
<i>Cephalopholis hemistiktos</i>	23 - 38	35	7	20.00
<i>Epinephelus polyphkadion</i>	21- 36	116	22	18.96
Other Species	10 - 95	960	0	00.00

Table 3: Showing infestation site of *Dermocystidium* infection

Fish species	locality	Gills	Muscle layer under the skin of trunk region	Connective tissue between the muscle bundles of the dorsal region.	Abdominal muscles.	Internal organs
<i>Johinus maculatus</i>	Qatef	+	-	++	-	-
<i>Lethrinus nebulosus</i>	Qatef	-	+++	-	-	-
<i>Lutjanus ehrenbergi</i>	Qatef	-	+	-	-	-
<i>Lutjanus malabaricus</i>	Qatef	-	+	-	-	-
<i>Cephalopholis hemistiktos</i>	Qatef	-	-	-	++	-
<i>Epinephelus polyphkadion</i>	Jeddah	+	-	-	-	+++

Fish Susceptibility and Site Distribution of Dermocystidium Infestation: As indicated in the present study, only 5 species were found susceptible to infestation with *Dermocystidium Arabica* in Qatef in their muscle while one species *Epinephelus polyphkadion* only infested with the same organism in Jeddah. In Qatef only one of them, had a yellow fusiform cyst in their gills (Fig.4.B). While in Jeddah had hyphal threads of *Dermocystidium Arabica* in gill lamellae (Fig.4.A) and in internal organs. The occurrence of *Dermocystidium* hyphae that represented by yellow spots or short brown sticks in the muscle of the infected fish were varies according to the host species. In *Lethrinus nebulosus*, *Lutjanus ehrenbergi* and *Lutjanus malabaricus* the yellow patches were observed in muscle layers under the skin of the trunk region and also found deeply in the musculature that faced to the vertebral column (Fig.1.A, B, C, F). Short brown sticks only appeared in the muscle of infected *Lethrinus nebulosus* (Fig.1.B). While in *Johinus maculatus*, the yellow threads were noticed only in the connective tissue between the muscle bundles of the dorsal region (Fig. 1. D & Fig. 3. A, B, C). *Cephalopholis hemistiktos* had a web of yellow threads (Hyphae) only in the abdominal muscles (Fig.1. E). Site distribution of dermocystidium infestation was clarified in Table 3.

Degree of Infestation and Size Relationship: As indicated the highest intensity of infestation with *Dermocystidiosis* was found in *Lethrinus nebulosus*, where the entire muscles under the skin and also that faced to the vertebral column, were covered

with yellow coloration (Fig.1.A&B). Brown colored groups of threads (hyphal like structure) were also seen within the muscles of *Lethrinus nebulosus* (Fig.1.B). A moderate intensity of infestation was detected in *Johinus maculatus* & *Cephalopholis hemistiktos*. In *Johinus maculatus* the yellow threads (hyphae) were spread along the connective tissue, which separate between muscle bundles of the dorsal region (Fig. 1. D and Fig. 3. A, B, C). *Cephalopholis hemistiktos* had a web of yellow threads (Hyphae) only in the abdominal muscles (Fig.1. E). On the other hand, low infestation was found in *Lutjanus ehrenbergi* and *Lutjanus malabaricus*, where small yellow spot area were observed in the musculature under the skin of the infected fish (Fig.1.C). Two fish species, *Johinus maculatus* & *Epinephelus polyphkadion* had *Dermocystidium* cysts or hyphae in their gills. Only one fish species, *Epinephelus polyphkadion* had *Dermocystidium Arabica* in the internal organs, liver, spleen and kidney.

The larger fish species infected with *Dermocystidium Arabica* was *Lethrinus nebulosus* <45 cm followed by *Johinus maculatus* <40 cm followed by *Lutjanus malabaricus* < 30 cm followed by *Cephalopholis hemistiktos* < 25 cm while the lowest length was for *Lutjanus ehrenbergi* < 20 cm.

Seasonal Prevalence: It was recorded that the highest seasonal prevalence was noticed at spring season 26.40 % followed by summer season 22.88 %, followed by autumn 17.19 % and the lowest infestation rate was recorded at winter 14.16 % Table 4.

Table 4: Seasonal prevalence of Dermocystidiosis in investigated marine fish species

Fish sp.	Winter			Spring			Summer			Autumn		
	No.	No.	%	No.	No.	%	No.	No.	%	No.	No.	%
	Exam.	Infect.		Exam.	Infect.		Exam.	Infect.		Exam.	Infect.	
<i>Johinus maculatus</i>	20	6	30	35	15	42.58	40	15	37.5	25	9	36.5
<i>Lethrinus nebulosus</i>	45	4	8.88	65	12	18.46	80	8	10	70	6	8.57
<i>Lutjanus ehrenbergi</i>	15	3	20	25	8	32	30	9	30	10	3	30
<i>Lutjanus malabaricus</i>	8	1	12.5	15	4	26.66	12	3	25	10	2	20
<i>Cephalopholis hemistiktos</i>	9	0	0	12	4	33.33	8	2	25	6	1	16.66
<i>Epinephelus polyphekadion</i>	23	3	13.04	26	4	15.38	31	9	29.03	36	6	16.66
Total	120	17	14.16	178	47	26.40	201	46	22.88	157	27	17.19

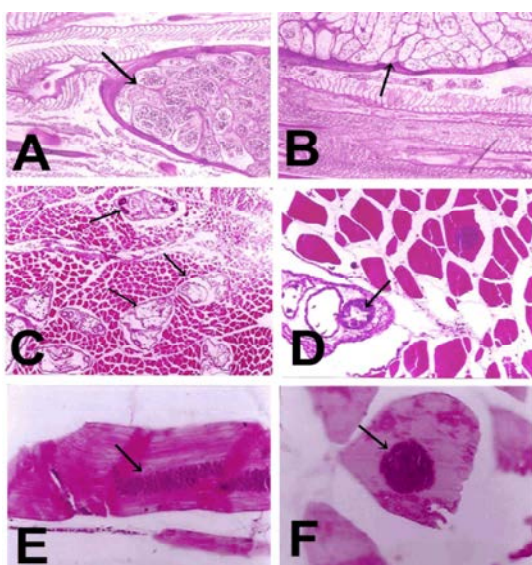


Fig. 7: Showing (A&B) Many hyphae of *Dermocystidium Arabica*, contain a large number of unicellular spores (Arrows), embedded along the secondary gill lamellae with hyperplasia of secondary gill filaments, the hyphae and spores substitutes the branchial tissues, (C&D) Cross sections of infected musculature showing many hyphal-like structures filled with a massive numbers of oval spores between the muscle bundles (Arrows) (E) Longitudinal section of skeletal muscle fiber of *Johinus maculatus* showed penetrated spores in the muscle fibers (Arrows) (F) Cross section of skeletal muscle fiber of *Johinus maculatus* showed central area of sporulation (Arrows).

Histopathological Examination: The histopathological examination revealed the presence of *Dermocystidium Arabica* Hyphae embedded along the primary gill lamellae with different stages of hyperplasia of secondary gill filaments. mononuclear inflammatory cells infiltration was not uncommon. The branchial tissue of the affected parts

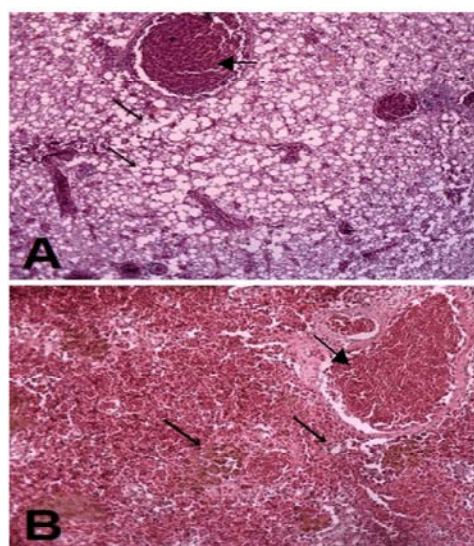


Fig. 8: Showing (A) liver of *Epinephelus polyphekadion* suffered from vacuolar degeneration with deposition of dermocystidium spores (Arrows), (B) spleen of *Epinephelus polyphekadion* showing deposition of hemosiderin pigments degeneration with deposition of dermocystidium spores (Arrows) X100 H&E.

in many cases was nearly substituted by the spores (Fig 7, A&B). The infected muscle fibres revealed large numbers of hyphal-like structures, filled with large numbers of spores in intermuscular spaces (Fig 7 C&D). The spores were also noticed within the muscle fibres (Fig 7 E&F). Moreover, *Dermocystidium* hyphae, also appeared in the internal organs such as liver, spleen and kidney in *Epinephelus polyphekadion*. The hepatocytes suffered from vacuolar degeneration (Fig. 8.A). In such cases, *Dermocystidium* cyst filled with numerous spores were also noticed. Spleen of *Epinephelus polyphekadion* showed deposition of hemosiderin pigments (Fig. 8.B) and nearly the same *Dermocystidium* hyphae filled with large numbers of spores.

DISCUSSION

Dermocystidiosis, a disease due to *Dermocystidium* infection, in fishes have been reported from nearly all parts of the world by various authors [1,4,6,8, 12,20-22]. More than 20 species of *Dermocystidium* commonly occur in fishes and they produce diseases, which have been associated with fish mortalities [5,6,14,16,23,24]. *Dermocystidium* characterized by formation of cysts on the skin or gills of many fish species [4, 9, 10]. Dyková and Lom [25] observed hyphae in association with *D. koi* in the hypodermal connective tissues of *Cyprinus carpio* var. *koi*, providing evidence for the fungal nature of skin-infecting *Dermocystidium* spp. The evidence of skin dermocystidiosis (Nodular cap disease) was detected in ornamental gold fish *crassius auratus* [26]. There have been a few cases of visceral and systemic infections in salmonid fish by an intracellular parasite identified as a *Dermocystidium* species [13-16]. The cyst or hyphal contents of the *Dermocystidium* species were packed with a massive number of variable sizes of spores [11].

The present study was designed to throw the light on *Dermocystidium* sp. which infest some marine fish species at the Eastern province at Qatef and Jeddah of Saudi Arabia, recording clinical and post mortem signs, prevalence, intensity of infestation, seasonal variation of the infestation, detect the size of the infected fish and investigate the histopathological alterations which may produced by these organism infestation.

Concerning the clinical picture and post mortem signs of Dermocystidiosis, present study displayed that, it may be varies considerably, since there are no uniform symptoms. Fish with light or moderate Dermocystidiosis not showed any clinical abnormalities and appeared to be perfectly normal. Detached scales, dull of color with turbidity or opaque of various parts of the body and emaciation with shrunken abdomen were observed in some cases of heavily infested fish of *Lethrinus nebulosus*. In postmortem examination, the main signs of disease were the appearance of yellow spots in the musculature of the all infested fish from Arabian Gulf. *Lethrinus nebulosus* with heavy infestation showed short brown sticks in their muscle. One fish species, only *Johinus maculatus* had a yellow fusiform cysts in their gills while *Epinephelus polyphkadion* was observed had short white threads in between primary gill lamellae. Because yellow color of the muscle was the prominent sign of the all infected fish from Arabian Gulf in our study and because previous articles not deal with this phenomenon, it was suggested naming this disease with "Yellow Muscle Disease".

The clinical signs of infested *Epinephelus polyphkadion* in Jeddah differ than those of the rest of infested fishes in Qatef (*Johinus maculatus*, *Lethrinus nebulosus*, *Lutjanus ehrenbergi*, *Lutjanus malabaricus* and *Cephalopholis hemistiktos*) the opaque with blue mucous mainly at the upper part of the body surface with white threads in between the primary gill lamellae, the results nearly agree with Feist *et al.* [10] and Bruno [22] who reported that Members of the genus *Dermocystidium* infect a variety of fish hosts and several species infecting skin, fins and gill.

In present study, typical spores of genus *Dermocystidium* were isolated from gills, muscles and visceral organs, liver and spleen. In fresh preparations, spores appeared spherical or oval in shape, variable in size, with a large central inclusion body (Signet-ring stage) and a narrow peripheral cytoplasm, which is the diagnostic feature of the genus *Dermocystidium* [5, 24, 27]. The spores were readily detected in Giemsa-stained imprints, where most spores appeared as slightly dark-stained oval or spherical bodies. Moreover, Histological examination revealed spores contained a prominent inclusion body, which gave a positive reaction for PAS. *Dermocystidium* represents a unique case when a stage of the life cycle of a eukaryote lacks a typical nucleus. The plasmodial stages of *D. percae* have a most unusual behavior of nuclei [28]. Early stages have an ordinary nucleus with double, fenestrated envelope. In middle-aged plasmodia ordinary nuclei seem to be totally absent or are only seldom discernible until prior to sporogony, when rather numerous nuclei again reappear [4]. In this study, spores lack a typical nucleus resembling same spores of *Dermocystidium aegyptiacus* that isolated from the intestine of cultured *Oreochromis niloticus* in Egypt [29].

Lom and Dykova [1] defined the description of the genus *Dermocystidium*, dividing the known species into three groups according to their morphology and predilection site of infection. Group 1 e.g. *D. branchiale* [30] were assigned walled multi-nuclear plasmodia (Cysts) formed usually in the skin, fins and gills of fish. These plasmodia divide to form round spores with a solid refractile body. In group 2 e.g. *D. koi* [31], thick-walled hyphae are formed in the hypodermal connective tissues of infected fish and the spores are of variable size. Within the hyphae, multinucleate cytoplasmic contents eventually produce a large number of spores with a typical central refractile inclusion. The species in group 3 e.g. *D. macrophagi* [15] cause visceral infections, a large thick-walled plasmodium (Cysts) is absent and the spores have a large central vacuole instead of an inclusion.

In this regard, *Dermocystidium* sp. obtained from the present study resembles *D. koi* [31] in group 2 in they all developing within a web of aseptate hyphae, but differ in their shape, host species and in microhabitat preference of the hyphae on the infected fish. Yellow web of aseptate hyphae found in musculature of 5 fish species from Arabian gulf (*Johinus maculatus*, *Lethrinus nebulosus*, *Lutjanus ehrenbergi*, *Lutjanus malabaricus* and *Cephalopholis hemistiktos*), short brown hyphae in the muscle of *Lethrinus nebulosus*, short white hyphae in between primary gill lamellae of *Epinephelus polyphekadion*. One fish species, *Johinus maculatus* had yellow fusiform cysts in their gills. Otherwise, spores of *Dermocystidium koi* developing within hyphae in subcutaneous tissues of a koi carp *Cyprinus carpio* [25]. Because the *Dermocystidium* sp. in this study is different from previous species in morphology, predilection site and host species, therefore, it can be considered as a new species under name *Dermocystidium Arabica* sp. n.

Concerning prevalence of infestation with *Dermocystidiosis*, present study revealed that the total prevalence of *Dermocystidiosis* among investigated fish at Qatef was 7.66% while the prevalence in Jeddah was 18.96% the total prevalence was 8.47%. The data indicates that highest incidence of infestation with *Dermocystidium* sp. was found in *Johinus maculatus* (37.50%) followed by *Lutjanus ehrenbergi* (28.75%) followed by *Lutjanus malabaricus* (22.50%) followed by *Cephalopholis hemistiktos* (20.00%) followed by *Epinephelus polyphekadion* (18.96%) and lowest prevalence was for *Lethrinus nebulosus* (11.53%). The results considered the first record of *Dermocystidiosis* in Kingdom of Saudi Arabia in two provinces Qatef and Jeddah, as there is no previous literatures record this disease in these regions.

The results of the present study disagree with the results of Feist *et al.* [10] who reported that the highest prevalence of *Dermocystidiosis* on bullheads, *Cottbus gobio* L. was approximately 50% in samples obtained from a river in southern England. Prevalence at other sites was 5% or less, its results indicated that prevalence might be changed from place to another according to water currents, temperature and water so on.

Dermocystidium species usually locate either in epithelial tissue of the skin, fins, gills and there have been a few cases of visceral and systemic infections [13-16]. The data obtained from present study indicate that *Dermocystidium Arabica* prevail on gills of two fish species, viscera of one fish species and for the first time from musculature of 5 fish species from Arabian Gulf and Red Sea coasts; Saudi Arabia. Only 5 species were found

susceptible to infestation with *Dermocystidium Arabica* in Qatef in their muscle while one species, *Epinephelus polyphekadion*, infested with the same organism in Jeddah. In Qatef only one of them, had a yellow fusiform cyst in their gills. While in Jeddah had white hyphal threads of *Dermocystidium Arabica* in gill lamellae and in internal organs, liver, spleen and kidney. The occurrence of *Dermocystidium* hyphae that represented by yellow spots or short brown sticks in the muscle of the infected fish were varies according to the host species. In *Lethrinus nebulosus*, *Lutjanus ehrenbergi* and *Lutjanus malabaricus* the yellow patches were observed in muscle layers under the skin of the trunk region and also found deeply in the musculature that faced to the vertebral column. Short brown sticks only appeared in the muscle of infected *Lethrinus nebulosus*. While in *Johinus maculatus*, the yellow streaks were noticed only in the connective tissue between the muscle bundles of the dorsal region. *Cephalopholis hemistiktos* had a web of yellow threads (Hyphae) only in the internal side of abdominal musculature.

Regarding size of fish infested with *Dermocystidium Arabica*, present study displayed that the larger fish species infected with *Dermocystidium* was *Lethrinus nebulosus* < 45 cm followed by *Johinus maculatus* < 40 cm followed by *Lutjanus malabaricus* < 30 cm followed by *Cephalopholis hemistiktos* < 25 cm while the lowest length was for *Lutjanus ehrenbergi* < 20 cm. The results disagree with Feist *et al.* [10] who reported that Both juvenile and adult fish were infected suggesting that all age groups are susceptible and Pekkarinen and Lotman [28] who reported that young perch acquire first infections in their first summer of life and fish over 3 years possibly develop some immunity. In Estonia, in the Kasari River and the Matsalu Bay, the difference may be attributed to species difference.

Concerning seasonal prevalence present study recorded that the highest seasonal prevalence was noticed at spring season 26.40% followed summer season 22.88% followed by Autumn 17.19% and the lowest infestation rate was recorded at winter 14.61%. The results nearly agree with the results of Dyková and Lom [25] who reported that the dams have been blamed for outbreaks of a fish parasite called *Dermocystidium*, which has killed as much as 80 percent of the fish runs before they could spawn in some years. A major outbreak of the parasite began in late September of this year. Scientists say water behind the dams is warmed by the sun and then increases the temperature in the lower river when it is released from the dam. Outbreaks of the parasite usually occur when the

river's temperature rises above 60 degrees. Pekkarinen and Lotman [28] reported that Sporogenesis of both *D. percae* and *D. sp.* takes place mostly in summer and at least in *D. percae* can continue until autumn. In addition, both species can produce numerous zoospores from their spores within 2 days in water at 25°C and at slower rates at lower temperatures.

Regarding the histopathological alterations, present study indicated Hyphae of *Dermocystidium Arabica* embedded along the primary gill lamellae with different stages of hyperplasia of secondary gill filaments with infiltration of inflammatory cells. Cross sections of the infected muscle, there was large numbers of hyphal-like structures, filled with varying large numbers of spores, were found within or between the muscle bundles, the results confirmed by Feist *et al.* [10] and Pekkarinen and Lotman [28].

From present study, it was concluded that Dermocystidiosis have not previously been recorded from fish from the Arabian Gulf and Red Sea coasts, Saudi Arabia, thus these findings are new locality records. The causative agent of this disease, *Dermocystidium sp.* in this study is different from previous species in morphology, predilection site and host species, therefore, it can be considered as a new species under name *Dermocystidium Arabica* present investigation indicated that *Dermocystidium Arabica* have been recorded from gills of two fish species, viscera of one fish species and for the first time from musculature (A new predilection site) of 5 fish species from Arabian Gulf and Red Sea coasts; Saudi Arabia.

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