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First Record of Microsporeans and Myxosporeans (Protozoa) Infecting Some Arabian Gulf Fishes off the Coasts of the Emirates and Qatar with a Description of *Myxobolus Arabicus* n. sp.

Abstract:During a comprehensive survey carried out on helminth parasites of Arabian Gulf fishes mainly from the coasts of the Emirates and Qatar, two microsporeans and three myxosporeans Protozoa were reported and described for the first time. The microsporeans included *Nosema sauridae* and *Glugea stephani*. *Nosema sauridae* was very common among lizard fish *Saurida undosquamis* which were caught from the Emirati coasts (56%) and also Qatari coasts (28%). *Glugea stephani* infected *Psettodes erumei* at the Emirati coasts with a prevalence of 10%. The myxosporideans comprised *Myxobolus arabicus* n. sp. from the body cavity of *Plectorhynchus schotaf* (Emirati coasts, 11%), *Kudoa sp.* from the musculature of *Lutjanus fulviflamma* (Emirati coasts, 8%) and also the heart wall of *Caranx malabricus* (Qatari coasts, 11%) and *Henneguya* sp. from the gills and mouth skin of *Epinephelus tauvina* (Emirati coasts, 7%). Fresh cysts and spores were described and photographed *in situ*.

Key words: Protozoa, Microsporea, Myxosporea, *Myxobolus arabicus*, fish parasites, Arabian Gulf.

أول تسجيل للأوليات الميكروسبورية والميكروسبوريدية المتطفلة على بعض أسماك الخليج العربي من شواطىء الإمارات وقطر مع وصف لنوع جديد وهو *Myxobolus arabicus*

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المستخلص: أثناء بحث موسع لدراسة الديدان الطفيلية التى تصيب أسماك الخليج العربي وخاصة شواطىء الإمارات وقطر، تم تسجيل نوعان من الميكروسبوريديا هما *Nosema sauridae* و *Glugea stephani*. وقد كان الأول شائعاً جداً بين أسماك الكاسور *Saurida undosquamis* بنسبة إصابة بلغت 56 % بين أسماك الإمارات و 28 % بين أسماك قطر. أما الثانى فيصيب أسماك الخوفعة *Psettodes erumei* من الإمارات بنسبة إصابة 10%. أما طفيليات الميكسوسبوريديا فقد شملت: *Myxobolus arabicus* كنوع جديد من تجويف الجسم لأسماك الفرش schotaf *Plectorhynchus* من الإمارات (11%) والطفيل الثاني من جنس *Kudoa* sp. من عضلات أسماك النيسر *Lutjanus fulviflamma* من الإمارات (8 %) وأيضاً من جدار القلب لأسماك الجش *Caranx malabricus* من قطر (11%). أما الطفيل الثالث فهو من جنس *Henneguya* sp. والذى سجل من الخياشيم وكذلك تجويف الفم لأسماك الهامور *Epinephelus tauvina* من شواطىء الإمارات بنسبة إصابة بلغت 7 %. وقد درست الجراثيم والحويصلات وصورت فى مكانها الطبيعى. هذا وتعتبر هذه الدراسة تسجيلاً أولياً لهذه الطفيليات الهامة.

كلمات مدخلية: الخليج العربي، أسماك ، طفيليات ، حيوانات وحيدة الخلية ، ميكروسبوريديه، ميكروسبورية.

Introduction

The microsporean and myxosporean parasites are mostly considered as a serious causative agent of many diseases in the fish farming and aquaculture industries. They have implications in marine fish farms, decreasing fish fecundity, retarding growth and increasing mass mortality (McVicar, 1975 and Nepszy *et al.* 1978). Unfortunately, no attention has been given to Myxozoan parasites in Arabian Gulf area. However, many species had earlier been recorded from Indian Ocean fishes (Narasimhamurti *et al.* 1980 and Seenapa & Manohen, 1981).

The Nosema and *Glugea* species cause very serious pathogenic conditions, specially in farm stocks (Putz & McLaughin, 1970). The *Kudoa* species infect the musculature of marine fishes and are considered as a well recognized cause of soft flesh, causing a great reduction in market value (Shaw *et al.* 1997). The *Henneguya* species has also an impact on fishes because it forms unsightly cysts in the somatic musculature and thus reduces economic value in marketing (Boyce *et al.* 1985). Some species of the Myxobolus, such as *M. cerebralis*, cause whirling disease, which is

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considered as one of the most dangerous agents in giving a high mortality rate in fish farming (El-Tantawy, 1989 and Hoffmann, 1990).

Microsporidian protozoa present also a potential risk for humans. Sprague (1974) recorded *Nosema connori* from autopsy material from a human infant. Since then, many studies dealing with microsporidiosis have been carried out (Rogowaka *et al.* 1994 and Weber & Deplazes, 1995). As far as can be followed, no previous studies have been reported on Arabian Gulf fishes and the current survey is considered as the first, but preliminary, and more studies will be considered in the future.

Materials and Methods

During our continuous studies on parasites of the Arabian Gulf, firstly from the Emirati coasts during the period of 1986 up to 1993 and later from Qatari coasts, from 1996 till 2000, more than 40 species of fish were examined for helminth parasites. About 6 species were found harboring microsporean and myxosporean cysts (Table 1). In the Emirates, most fish were collected either from the markets of Dubai and Sharjah, which are located directly beside the seashore or from fishermen who have small fishing boats. Some fish species brought from the fish markets of Abu Dhab, Ras Al Khaimah and Khor Faccan.In Qatar, fish were collected from the Doha fishing port market. Some cysts were removed, placed on objective slides and exudated in glycerin-gelatin without any additional staining. Spores were examined freshly with a light microscope using dark illumination using (450x) and (1000x). Some spores were stained with Giemsa for more details. Others were placed in iodine to identify glycogen vacuoles. Some fresh cysts and spores were photographed in *situ*. All measurements are given in microns unless otherwise stated.

Table 1: Microsporeans and Myxosporeans Infecting Arabian Gulf Fishes

Parasites	Hosts (No.)	Habitat	Localities at Arabian Gulf	Prevalence (%)
Microsporea:				
1- *Nosema sauridae*	*Saurida undosquamis*(175)	Body cavity and organs	Emirati coasts Qatari coasts	56 28
2- *Glugea stephani*	*Psettodes erumei* (48)	Body cavity near heart	Emirati coasts	10
Myxosporea:				
1- *Myxobolus arabicus* (n. sp.)	*Plectorhynchus schotaf* (38)	Body cavity	Emirati coasts	11
2- *Kudoa* sp.	*Lutjanus fulviflamma* (25) *Caranx malabricus* (65)	Musculature Heart wall	Emirati coasts Qatari coasts	8 11
3- *Henneguya* sp.	*Epinephelus tauvina* (42)	Gills and mouth skin	Emirati coasts	7

Results

A. Microsporea

1-*Nosema sauridae* (Narasimhamarti & Kalavati, 1972)

Host: *Saurida undosquamis*
Habitat: Visceral muscles, kidneys, gonads and body cavity.
Locality: Emirati and Qatari coasts.
Prevalence: Emirati coasts (56%) and Qatari coasts (28%).

Description: (see Table 1, Figs. 1-4). Many ovoid to rounded cysts were seen embedded in visceral muscles and many organs, especially the ovaries (See Fig. 3) and kidneys (Fig. 4). Cysts ranged from 2.4 mm. to nearly 4.2 mm. When fresh cysts were crushed in saline, highly refractile spores were revealed. Spores are ovoid to pyriform with 2.8-3.4μm length and 1.2-2.2μm width. The fresh spores didn't exhibit any internal structure except the presence of a central vacuole. When stained with Giemsa. a dot-like polar cap was observed at the anterior end (Fig. 1). Some spores revealed the cytoplasm as a central band with one nucleus inside. The sporonts inside each cyst developed into a single spore.

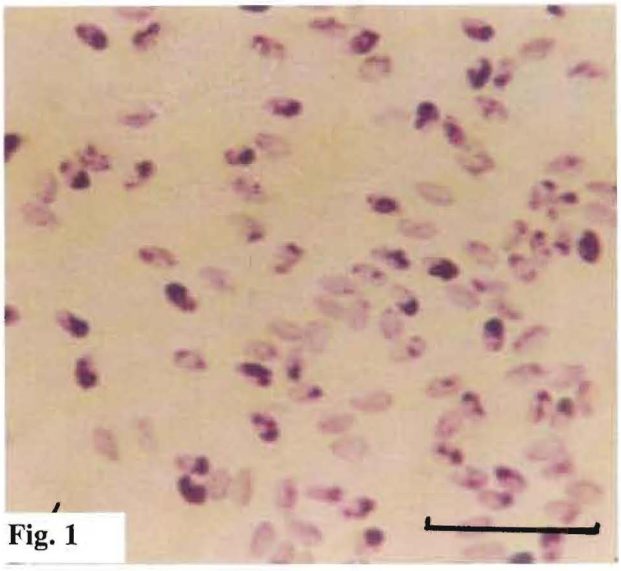

Fig. 1

Spores stained with Giemsa. Scale bar 50 μm.

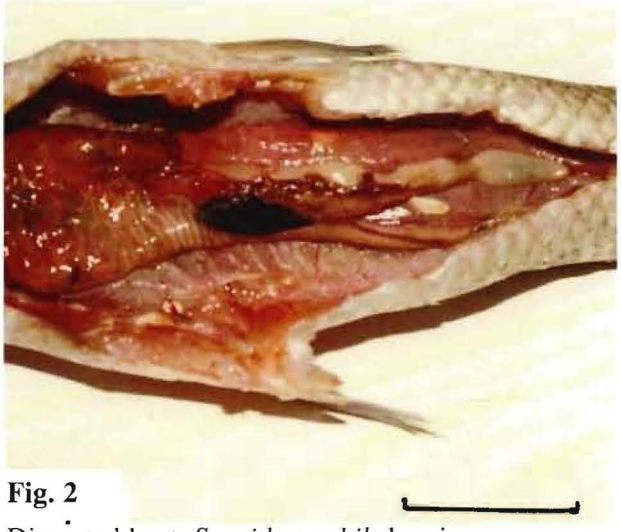

Fig. 2

Dissected host, *Saurida tumbil* showing Pseudocysts attached to different organs in the body cavity. Scale bar 10 mm.

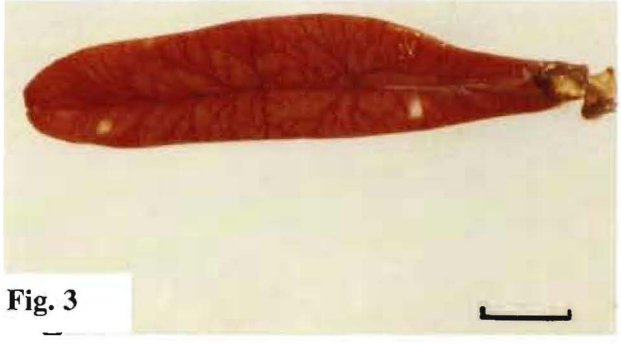

Fig. 3

Ovaries of *Saurida tumbil* infected with pseudocysts of *Nosema sauridae*. Scale bar 10 mm.

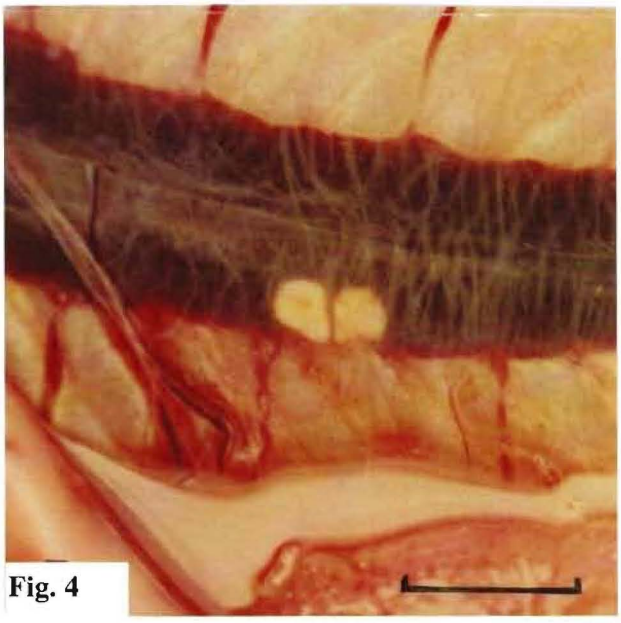

Fig. 4

Two Pseudocysts of *Nosema sauridae* attached to a kidney of Saurida tumbil. Scale bar 10 mm.

Remarks: *Nosema sauridae* was first proposed by Narasimhamarti, C. and Kalavati, C. (1972) as a microsporidean detected from *Saurida tumbil* at Visakhapatne on the east coast of India. In our investigation this species is repeatedly observed from the *S. undosquamis* host collected from both Emirati and Qatari coasts. According to Kudo (1933) this species was assigned to genus *Nosema* instead of *Pleistophora* since each sporont develops into a single spore instead of sixteen. Our specimens have spore measurements nearly in the same range as Indian Ocean specimens,(2.8-3.4μm x 1.2-2.2μm against 2.3-3.8μm x 1.8-2.0μm).

2- *Glugea stephani* (Hagenmuller, 1899)

Host: *Psettodes erumei*
Habitat: Body cavity in mesenteries of intestine.
Locality: Emirati coasts.
Prevalence: 10%.
Description: (see Table 1, Fig. 5). Several ovoid cysts were observed in the body cavity embedded in intestinal mesenteries. They measured about 1.5-2.2 mm long. When cysts were crushed, the exudate found contained hundreds of spores. By examination with light microscopy, these fresh spores have an ovoid shape but are slightly attenuated anteriorly (Fig.5). They have a length of 3.2-5.6μm and a width of 2.8-3.6μm. A spore was highly refracted and exhibited no internal structure except an obvious central vacuole with a cytoplasmic rim around and an anterior refractile portion representing the anterior capsule. One or two nucleii were observed inside.

Fig. 5
Light micrograph of fresh spores of *Glugea stephani* from body cavity of *Psettodes erumei*. Scale bar 10 μm.

Remarks: *Glugea stephani* is a common microsporean parasite of many flatfish like English sole *Parophrys vetulus*, the plaice *Pleuronectes platessa* and the American winter flounder *Pseudopleuronectes americanus* (McVicar, 1975; Olson, 1976 and Takvorian & Cali, 1981). The currently investigated specimens reveal that these parasites have characteristics consistent with *G. stephani* described by Olson, 1976 except for minor differences in spore dimensions. When compared with the English type the average width was found less than in Arabian Gulf species (3.9 x 1.7μm by 4.4 x 3.2μm). *Psettodes erumei* is considered as a newly recorded host.

B. Myxosporea
3- *Myxobolus arabicus* n. sp.

Host: *Plectrorhynchus schotaf*
Habitat: Body cavity near heart.
Locality: Emirati coasts.
Prevalence: 11%
Description: (see Table 1, Figs. 6-8). Many milky white pseudocysts were found aggregating near the heart in the body cavity (Fig. 8). Cysts were nearly spherical shaped, 2.4-2.8 mm. in diameter. Developed trophozoites were not found. Spores are coelozoic, typically ovoid in vulvular view and tenticular in side view, 8.0-10μm long and 6.0-7.0μm wide. The shell valve was smooth without suture ridges, 0.8-1.0μm thick. Polar capsules were symmetrical, pyriform in shape and occupying nearly 40% of the spore length, 2.0-4.0μm long. The discharging channel of each capsule runs side by side along the edge of the valves and opens divergent anteriorly. An inter-capsular appendix is absent but instead a thickening is present. Each capsule has 5-7 filamentous coils which are arranged perpendicular to the long axis of the capsule. The sporoplasm is finely granular and

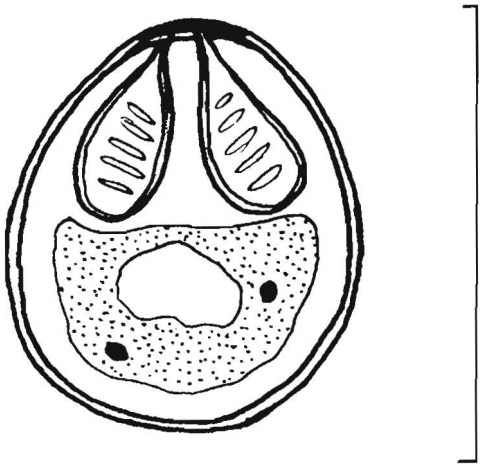

Fig. 6. *Myxobolus arabicus* n. sp., Scale bar 2.5 μm.

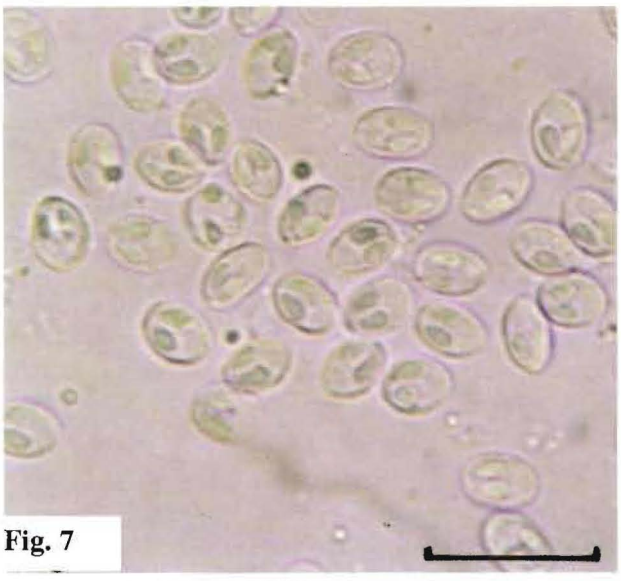

Fig. 7
Fresh spores. Scale bar 5 μm.

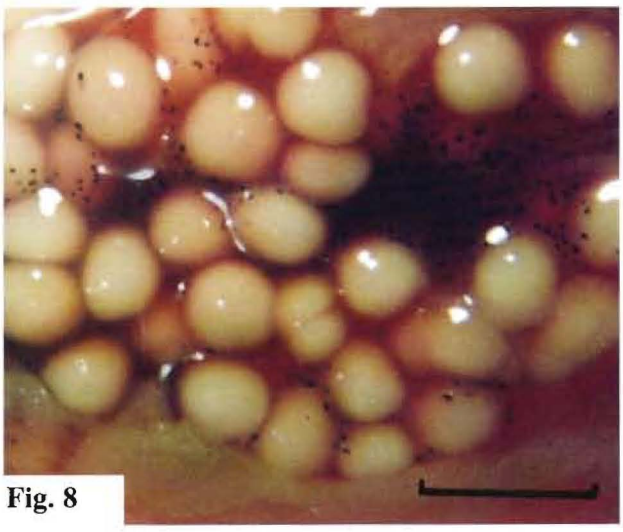

Fig. 8
White milky pseudocysts aggregating in the body cavity of *Plectrorhynchus schotaf*. Scale bar 5 mm.

binucleate. An iodinophilous vacuole is present.

Remarks: In marine and brackish species related to genus *Myxobolus*, a few were harbored in the body cavity. Among those are: *Myxobolus osburni* (Herrick, 1936) from *Lepomis gibbosus* in Ryan Lake, Canada; *M. indicum* (Tripathi, 1951) from *Cirrhina mrigala*, India; *M. magnaspherus* (Cone & Anderson, 1977) from *Lepomis gibbosus* in Ryan Lake, Canada; *M. talievi* (Dogiel & Bogolepova, 1977) from sculpins from Lake Baikal, USSR; *M. bhadrensis* (Seenappa & Manohar, 1981) from Labeo rohita, India; *M. paralintoni* (Li & Desser, 1985) from *Lepomis gibossus*, Lake Sasajewan, Canada; *M. conei* (Lom & Dycova, 1994) from the liver and bile ducts of Pseudocaranx dentex, Australia; *M. jollimorei* (Cone & Overstreet, 1998) from *Lepomis macrochirus*, Lake Erie, Canada and *M. manueli* (Cone & Overstreet, 1998) from Pomoxis nigromaculatus, Lake Erie, Canada.

M. arabicus differs from *Myxobolus osburni*, *M. magnaspherus*, *M. talievi*, *M. paralintoni* and *M. jollimorei* in the absence of sutural ridges, the oval instead of circular shape and the divergent polar capsules, which are convergent in the others. Furthermore, the new species didn't have sub-lateral crested sutural ridges, as seen in *M. conei* and also didn't have the two short lateral knobs present in the sutural ridge of *M. manueli*. In size and shape the spores of *M. arabicus* closely resemble *M. magnaspherus* and *M. bhadrensis*, but these two species have distinct unequal polar capsules. In view of these differences we consider our specimens as a new species.

4- *Kudoa* sp.

Host: *Lutjanus fulviflamma* (8%) and *Caranx malabricus* (11%).
Habitat: muscles and heart wall.
Locality: Emirati and Qatari coasts.
Description: (see Table 1, Figs. 9-12). Large white spindle shaped pseudo-cysts were found within muscle fibres (Fig. 12). Each was about 1.0-1.5 cm. in length and 0.2-0.5 cm. in width. The cysts were completely filled with spores. Wet mount preparations reveal stellate spores with four valves and four polar capsules (Fig. 10). In polar view each spore exhibits 4 deep notches extending deeply in the vulval wall resulting in 4 rounded equal parts (Fig. 11). The posterior part of the valve surface is convex in side view and the anterior part is blunted. The spores are 4.0-6.0μm in length and 8.0-10 in width. The polar capsules are elliptical, convergent and have uniform size, each 2.2-2.5μm in length and 1.2-1.5μm in width. The filament, when fully extended, has a length of 5.0-8.0μm.

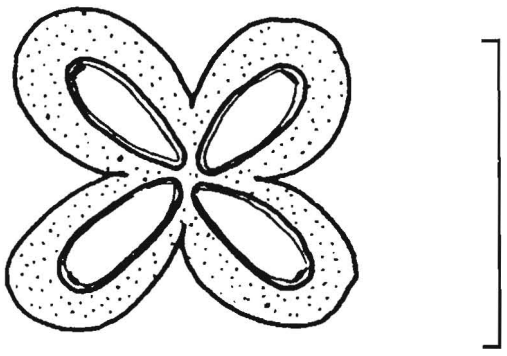

Fig. 9. *Kudoa* sp., Scale bar 10 μm.

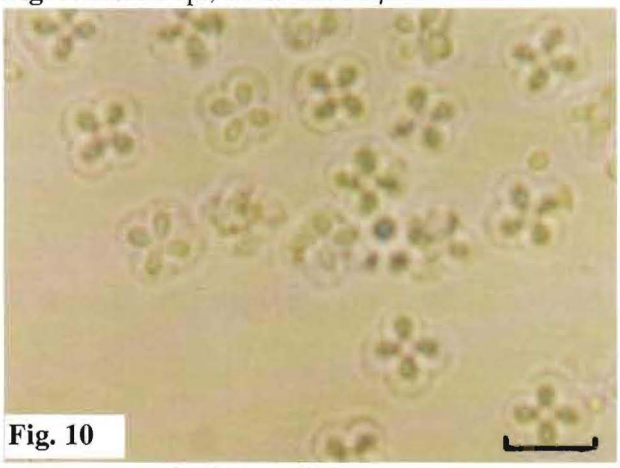

Fig. 10
Fresh spores. Scale bar 10 μm.

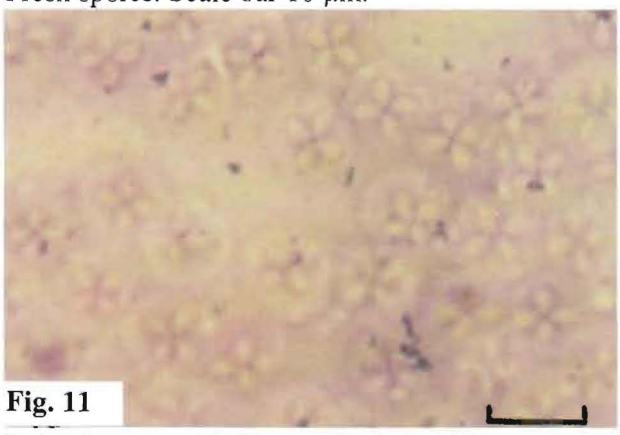

Fig. 11
Stained spores with Giemsa. Scale bar 10 μm.

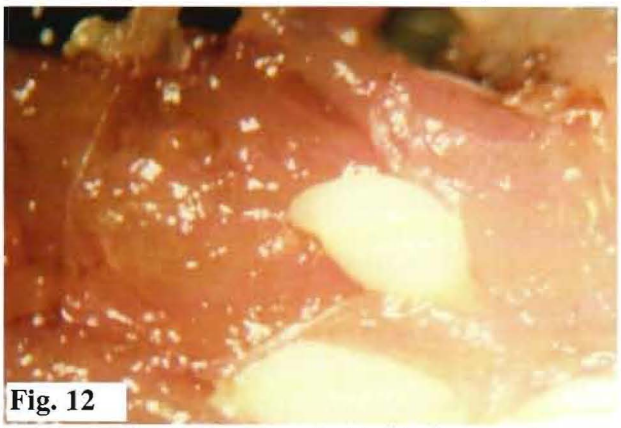

Fig. 12
Three pseudocysts found embedded in the somatic musculature of *Lutjanus fulviflamma*. Scale bar 10 mm.

Remarks: Genus *Kudoa* was established by Meglitsch (1947) for members belonging to myxosporea which are histozoic with stellate spores. He proposed *K. clupeidae* as the type species. It mostly infects fish muscles worldwide (Narasimhamurti & Kalavati, 1979; Obeikezie *et al.* 1987; Yukio *et al.* 1993 and Whitaker *et al.* 1996). Maeno (1993) stated that about 30 species were described related to the genus and proposed *K. intestinalis* as a new species. Our specimen characteristics are nearly consistent with *K. intestinalis*, but it is convex posteriorly and has a blunted anterior end. Since morphometric data from light microscopy alone is not adequate, no precise identification has been done. Further studies will be undertaken in the future.

5- *Henneguya* sp.

Host: *Epinephelus tauvina*
Habitat: Gill filaments and skin of the mouth near the upper jaw.
Locality: Emirati coasts.
Prevalence: 7%
Description: (see Table 10, Figs. 13-15). White opaque spherical cysts were seen between gill filaments (Fig. 15). Their diameter was 2.5-2.8 mm. Each cyst was full of spores in different developmental stages. The spores had a biconcave body shape which was compressed parallel to the sutural plane (Fig. 14). The anterior end was blunted with obvious thickening between the capsular openings. Spores have a length of 12.2-12.6µm (without appendages) and a width of 8.0-10µm. Three sutural ridges are clearly seen in the posterior half of the body. Polar capsules are symmetrical, are pyriform divergent anteriorly and have a length of 4.5-5.5µm. The body is extended posteriorly into a very long bifurcated caudal appendage. It reaches about 32.2-32.8µm in length. One or sometimes two nucleii are seen inside the sporoplasm and there is also an iodinophilous vacuole.

Fig. 13 *Henneguya* sp., Scale bar 2.5µm.

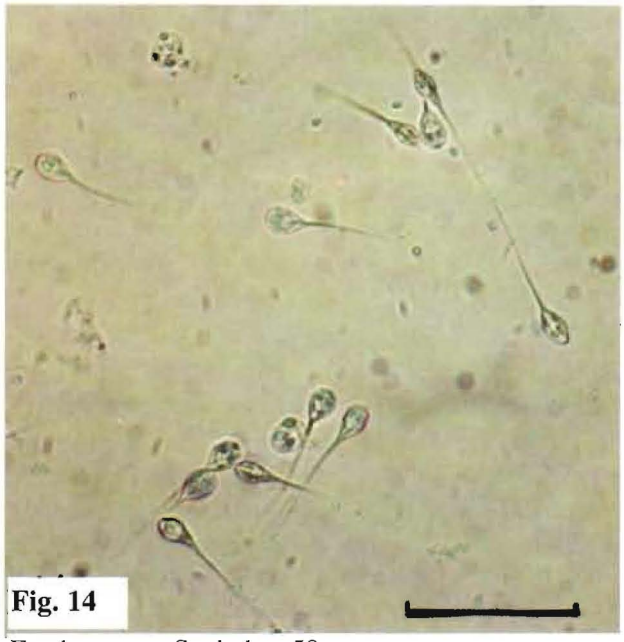

Fig. 14
Fresh spores. Scale bar 50 µm.

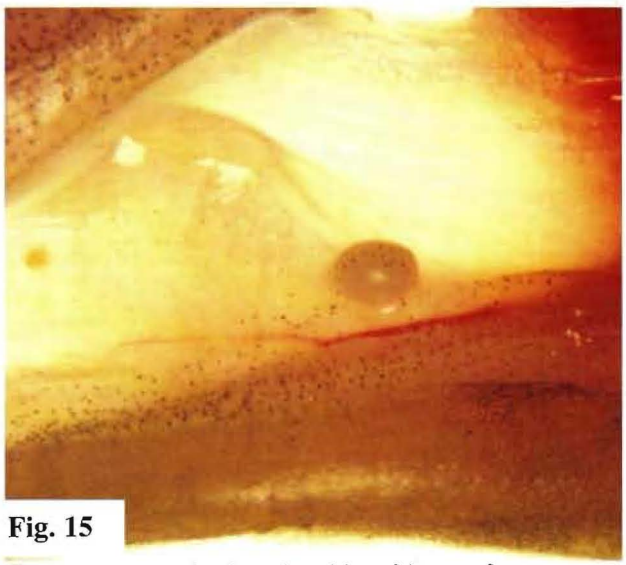

Fig. 15
Two cysts attached to the skin of jaws of Epinephelus tauvina. Scale bar 5 mm.

Remarks: *Henneguya* species are world wide myxosporean parasites which infect gills and skin of mainly fresh water fish (Minchew, 1977). However, they also infect marine fishes (Cone, 1994). Some species, like *H. salmonicola*, infect somatic muscles causing softening of flesh and leave fish with less market value (Kent *et al.* 1994). As the characteristics of our investigated specimens were exactly consistent with genus *Henneguya*, they are assigned to it. No precise identification was achieved because the few cysts obtained were crushed during processing.

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