New observations on Myxozoa of the goldline sea bream *Sarpa salpa* L. 1758 (Teleostei : Sparidae) from the Mediterranean coast of Tunisia

SAYEF LAAMIRI
Département de Biologie, Faculté des Sciences de Tunis, Université Tunis El Manar, 2092, Tunisie.
E-mail : laamiri_sayef@ymail.com; Tel: +216 20 94 49 28

Abstract
A member of the Sparidae family, the goldline sea bream *Sarpa salpa* (Linnaeus, 1758) collected from the Gulf of Tunis and the Bay of Bizerte in Northeast Tunisia, Western Mediterranean, were examined for the myxozoan parasites. During the parasitological exposure, a total of 7 myxosporean are found including 6 coelozoic species belong to the genus *Ceratomyxa* Thélohan, 1892 infected the gallbladder of their host of which 3 known species have been previously described, *C. arcuata* Thélohan, 1892, *C. pallida* Thélohan, 1895 and *C. herouardi* Georgévitch, 1916 and 3 species seem different in morphology to *Ceratomyxa* spp already known from Mediterranean Sea or from other localities in the wide world. These species are *Ceratomyxa* sp. 1, *Ceratomyxa* sp. 2 and *Ceratomyxa* sp. 3. Only one histozoic species belongs to the genus *Henneguya* Thélohan, 1892, *Henneguya* sp. identified for the first time infecting the mesentery vessels of *S. salpa*. The myxosporean parasite *C. arcuata* Thélohan, 1892 is reported for the first time in Tunisian waters from the goldline sea bream which represents as new host records. In addition to the Monoparasitism, the phenomenon of Polyparasitism was observed between the current species in both sampling sites with two types: Biparasitism and Triparasitism. The most frequent Polyparasitism was a Biparasitism-type between *C. herouardi* and *C. pallida* with frequency 16.97%. For all the species, no serious pathogenic changes have been recorded in the host organ or in the outward appearance of the fish. Morphological features, site of infection into the host, parasite prevalence and mean intensity of each myxosporean found during this survey are determined and their taxonomic affinities to other species are discussed.

Key words: Myxozoan fauna, *Ceratomyxa*, *Henneguya*, Morphology, Taxonomy, Biparasitism, Triparasitism, *Sarpa salpa*, Sparidae, Mediterranean coast, Tunisia

Introduction
The goldline sea bream, Salema or Strepie, *Sarpa salpa* (Linnaeus, 1758), is a benthopelagic oceanodromous sparid fish widely distributed throughout the Mediterranean and the Eastern Atlantic coast (round South Africa to South of Mozambique including the Azores and Canary Islands), living on sandy and seagrass bottoms ranging from 0 to 70 m depth (Bouchot & Hureau 1990). In the Mediterranean Sea, during the last 15 years, the goldline sea bream has attracted research interest because of first, its ecological key role as mainly vertebrate of the seagrass *Posidonia oceanica* (L.) (Peirano et al. 2001; Jadot et al. 2006; Prado et al. 2008) and representing a considerable part of the ichthyofauna in these habitats (40–70% in biomass) (Francour 1997, 2000), second, its biology in order to develop a management strategy (Méndez-Villamil et al. 2001, 2002), and finally for its Ichthyosarcotoxism (Spanier et al. 1989; Chevaldonne 1990; De Haro & Pommier 2006; Bellassoued et al. 2012). In the Atlantic coast especially in Canary Island, *S. salpa* has an important commercial value and constitutes one of the most important fishes taken by the local artisan fleet (Méndez-Villamil et al. 2002). In Tunisia, the goldline sea bream is commonly consumed as fresh fish for its desirable aroma and quality (Boubaker et al. 2013). Statistical data revealed that the total production of this fish, along the Tunisian coast, has increased between 1980 and 2001 about 70.3% where in 2001, the production has reached 1024 tons, which constitute 57% of the total catch that was taken in Mediterranean Sea (Froese & Pauly 2014).

Myxozoans are a phylum of microscopic metazoan endoparasites belonging to the Cnidaria (Holland et al. 2011; Nesnidal et al. 2013). They represent a major group of fish parasites and their impact on wild and cultured
Myxozoans from Alama-Bermejo Pellitero, 1995 (Palenzuela 211.7 parasites per host whereas the mean intensity of modifications in prevalence rate of infection (Ferguson 1981; McGeorge) myxozoans and allow more rapidly proliferation in both, their vertebrate and invertebrate hosts, leading to well demonstrated that increased water temperature has particularly a crucial effect on the development of such as water temperature, salinity and pH are really important in the proliferation of these parasites. In fact, it was declared that prevalence of myxosporean species varies according to environmental conditions and hosts species. Mackenzie et al. (2005) provided that myxosporeans are highly sensitive to environmental change. Abiotic factors such as water temperature, salinity and pH are really important in the proliferation of these parasites. In fact, it was well demonstrated that increased water temperature has particularly a crucial effect on the development of myxozoans and allow more rapidly proliferation in both, their vertebrate and invertebrate hosts, leading to modifications in prevalence rate of infection (Ferguson 1981; McGeorge et al. 1996; Kent et al. 2001; Yokoyama 2003; Tops et al. 2006; Ray et al. 2012). In the same regard, El-Matbouli et al. (1999) determined that temperature can affect the development, release and longevity of the myxosporean in an alternate host as well as the development of the fish host. Likewise, Özer & Wootten (2000) showed a significant progressive development of both myxosporean and actinosporean stages in the life cycle of Spheropsora truttae with the water temperature. Soon after, kerans et al. (2005) exposed the positive influence of water temperature on Host-parasite interaction and dynamics transmission in the life cycle of myxosporean Myxobolus cerebralis.

In this study, both Ceratomyxa and Henneguya species did not seem to cause any inflicted external clinical signs of disease or visible abnormalities, neither in the host organ nor in the outward appearance of the fish. However, the pathogenic potentials of the coelozoic parasites, in particular their possible relationship with the dark green color of the bile and contraction in some part of the heavy infected gall bladder, should be further studied. For the histozoic Henneguya sp., the existence of large cysts into the mesentery can provoke occlusion for the vessels and cause nutrition and digestion troubles for the host fish. As a supplementary work, further investigations on the specific identities, such as phylogeny position and fine structure may help to enlarge the current knowledge.

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