

PATHOLOGICAL EFFECTS CAUSED BY *PENNELLA INSTRUCTA* (WILSON, 1917) (PENNELLIDAE) TO ITS HOST, *XIPHIAS GLADIUS* LINNAEUS, 1758 (XIPHIIDAE) OFF THE ALGERIAN COAST

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Abstract: Pathological effects caused to *Xiphias gladius* Linnaeus, 1758 by *Pennella instructa* (Wilson, 1917) were studied for the first time in Algerian coasts. Five specimens of *X. gladius* were captured in the gulf of Bejaia (eastern of Algerian coast) from February to May 2020. Infection rates by *P. instructa* reached P=100%. On the same specimen of *P. instructa* many barnacles (8 specimens) were found fixed. Our macroscopic and microscopic (Histopathological studies) observations show that *P. instructa* causes many damages to its host (*X. gladius*): perforation, necrosis and hemorrhage in their fixing sites, ulceration in the skin, derma and muscle.

Keywords: *Xiphias gladius*, *Pennella instructa*, Pathology, *Conchoderma virgatum*, Algerian coast.

INTRODUCTION

Xiphias gladius Linnaeus, 1758 the only member of the Xiphiidae family, is a pelagic and migratory fish, with a worldwide distribution (Muscolino et al., 2012) with a range extending from tropical to cold-temperate oceans, including the Mediterranean Sea (Nakamura, 1985). It can grow to more than 3 m in length (Tserpes and Tsimenides, 1995; Sun et al., 2002). It represents one of the most important fish resources for the North Atlantic and the Mediterranean fisheries (Mattiucci et al., 2005). In Algeria, *Xiphias gladius* is one of the most important commercial fish species.

Parasites belonging to the Pennellidae family are the common crustaceans mesoparasites found in large pelagic fishes, males are free living; however, females attach to the body surface of host (Tuncer et al., 2010). Species belonging to the genus *Pennella* Oksen, 1816, have been collected from the flesh marine mammals and pelagic fishes like, *Xiphias gladius* L., *Mola mola* L., and many species attached to *Scombrids*, *Exocoebids* and *Coryphaenids* from the Pacific and Atlantic oceans, as well as the Mediterranean Sea (Yamaguti, 1963; Kabata, 1992; Pollock, 1994).

The most members of the family Pennellidae are mesoparasitic having large size (many centimeters), their penetration deep into the host in search of target site (Kabata, 1979). The penetration enhances mechanic alteration and maybe causing damages and pathologies to their hosts which induce probably economic losses.

In the Mediterranean Sea, several researchers report economic losses caused by copepodoses linked to the infection of fish by certain mesoparasitic copepods. Ben Hassine et al. (1990), Ben Cheikh (1993), Ben Cheikh et al. (1994) have shown that the copepod *Peroderma cylindricum* (Heller, 1865) has a negative effect on the growth and fertility of *Sardina pilchardus* (Walbaum, 1792).

Pennellids infecting *Xiphias gladius* were previously studied in the Mediterranean Sea, (Mattiucci et al., 2005; Öktener et al., 2007; Tanrikul and Akyol, 2010; Mattiucci et al., 2014; Massi et al., 2014). Other Pennellids like *Penella filosa* were reported on this fish

from the Mediterranean Sea by Raibaut et al. (1998). In Algerian coasts, Ramdane and Trilles (2010) and Ramdane (2009) reported 4 Pennellid species parasitizing especially teleost fishes: *Lernaeolophus sultanus* (Milne Edwards, 1840) found on *Pagellus acarne* (Risso, 1827) and *Boops boops* (Linnaeus, 1758), inserted in the roof of the mouth; *Peroderma cylindricum* (Heller, 1865) collected from *Sardina pilchardus* (Walbaum, 1792), inserted into the muscle behind the operculum; *Peniculus fistula* (von Nordmann, 1832) collected from the caudal fin of *Pagrus pagrus* (Linnaeus, 1758); *Pennella filosa* (Linnaeus, 1758) collected from *Sphyræna sphyraena* (Linnaeus, 1758). Mansouri et al. (2017) stated that although the low infection by Pennellids (*P. cylindricum* and *L. sultanus*), serious necrosis, alterations and atrophies were induced to the muscle and mouth cavity of their hosts.

Until now, no studies have been performed on Pennellids infecting *Xiphias gladius* from Algerian coasts especially studies reporting pathological effects caused by *Pennella instructa* to its host. The aim of the present study is to identify Pennellids mesoparasite species infecting *X. gladius* from Algerian coasts, and to determine their infection rates and their pathological effects.

MATERIALS AND METHODS

The parasites samples were collected from 5 specimens of *Xiphias gladius* Linnaeus, 1758; obtained from commercial landings in Bejaia (eastern coast of Algeria) from February to May 2020. Specimens were transferred to the laboratory; lengths were measured to the nearest 0.1 cm.

X. gladius body surface was visually examined for the copepod *Pennella spp.*; parasites found were taken out from the fish muscle, their number and any damage were noted and photographed, they were washed and cleaned in a water (H₂O) and stored in 70 % alcohol for further examination and identification according to Hogans et al.(1985) and Hogans (1986). Photos of *X. gladius* and its parasite were taken in the sampling site.

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The skin and muscular around the area of attachment of the parasite was directly examined and were preserved in 10 % formalin for histological studies of the possible pathological effects. The terms prevalence, mean intensity and abundance were calculated according to Bush et al. (1997). Infected and uninfected site were dehydrated in a graded series of alcohols (70 to 95%), embedded in paraffin, cut into 1 µm-thick serial sections, and stained with Mayer’s hematoxylin and eosin (H&E). The sections were examined using light microscopy and photographed using LEICA DM300 microscopy camera.

This is the first report of *Pennella instructa* infecting *X. gladius* from the Algerian coast and the first report of the cosmopolitan epibiont, *Conchoderma virgatum* on *Penella instructa* parasitizing *X. gladius*.

All examined *X. gladius*’s specimens were parasitized by this parasitic copepod. This parasite species infects females (112-131cm, 11.9-24.7 kg) as well as males (107-144cm, 10.6-23.45 kg) of *X. gladius* with high parasitological indexes (Prevalence=100%; Mean intensity = 5 parasites per infected host) (Tab.1). All collected parasite specimens were females (presenting long egg sacs) their size varies between 5.3 and 16.6cm (Tab.1).

RESULTS

Table 1.

Parasitological and pathological effects of *Pennella instructa*.

| Date | Number of the collected parasites | Fish Sex | Length (cm) | Weight (kg) | Parasite size, cm (min-max) | Fixing site and damages of the parasite / association with parasite |
|---|-----------------------------------|-----------|--------------------|----------------------|-----------------------------|--|
| February | 05 | F | 112 | 11,9 | 14-16 | Hemorrhage around the area of attachment of the parasite |
| | 07 | F | 131 | 23,45 | 13.5-15.2 | Lesions and fibrous cyst around the area of attachment of the parasite |
| March | 04 | M | 144 | 38,2 | 12.5-14 | Lesions around the area of attachment of the parasite |
| April | 06 | M | 107 | 10,6 | 8.7-12 | Lesions and hemorrhage around the area of attachment of the parasite |
| Mai | 03 | F | 126 | 24,7 | 5.3-16.6 | Lesions around the area of attachment of the parasite |
| Total, mean, global prevalence and mean intensity | 25 | 05 | 124 ± 14.88 | 21.77 ± 11.21 | / | Prevalence = 100 %. Mean intensity = 5. |

They present a long trunk, slightly thicker posteriorly; abdominal brush in line with trunk, covered by plumes (Fig. 2A, B, D) ; two lateral horns protrude from the head and extend posteriorly parallel to the neck (Fig. 2C, D, G); the surface of the head is covered by central and lateral papillae (Fig. 2H).

Penella instructa infects many parts of body surfaces of its host: lateral, ventral and dorsal sides, anal and pelvic fins, near operculum. Then, no specificity to the fixing site was observed (Fig. 1). Collected specimens of *P. instructa* were found inserted and embedded into the muscle with the neck and cephalothorax penetrating into the body cavity while the trunk, abdomen and egg sacs were outside the body of the fish (Fig. 1A, B, C, D, F).

Pennellid specimens of large size present a remarkable association with a barnacle cirriped species (*Conchoderma virgatum*). In some cases, we found 8 specimens of *C. vergatum* fixed on the trunk of this mesoparasitic copepod. Generally, small specimens of *X. gladius* do not exhibit this association (Fig. 3.).

Our results of macroscopic examination show that *P. instructa* induces pathogenic effects to its host (*X. gladius*): injuries, lesions, necrosis, and fibrous cyst formation as host reaction to the infection and hemorrhage around the area of attachment of the parasite

(Tab. 1; Fig. 1B, C, D, E and F). Parasitic cystic forms were observed into the host musculature (Fig. 1H) within cephalothoraxes and a portion of neck of the parasite (Fig. 2, E, F).



Fig. 1. A: *Xiphias gladius* with attached parasite *Pennella instructa*. B, C, D, F: *P. instructa* (red circles) attached to the different parts of the host's body. E: cyst (c) in the body (musculature). B, C, D, F: Haemorrhage (h) and formation of fibrous cyst (fc), host reaction to the infestation. **Scale bar: 2cm.**

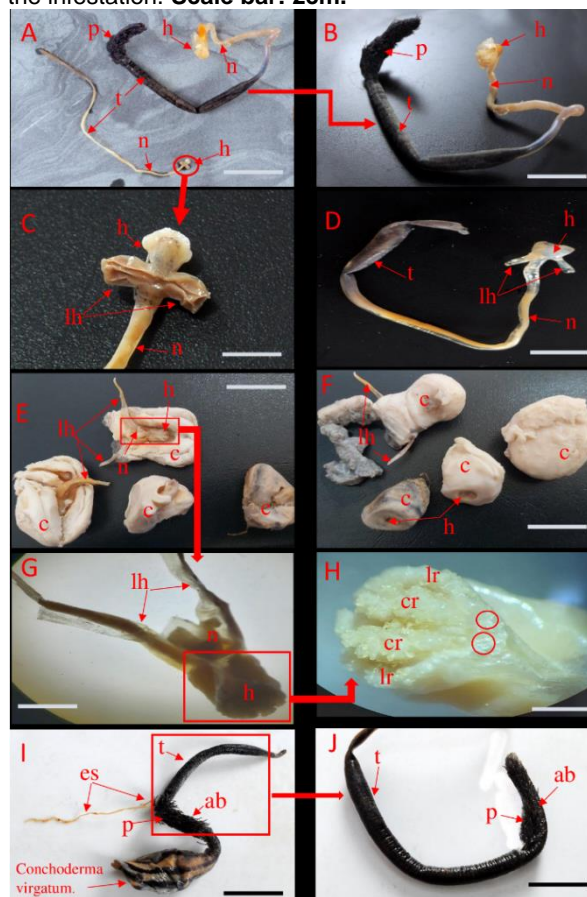


Fig. 2. A, B, D: General and macro-photographs of *P. instructa*. neck (n), lateral horns (lh), trunk (t), abdominal brush (ab) and plumes (p). C: Detail of neck (n) with head (h) and lateral horns (lh). I, J: Detail of trunk (t), abdominal brush (ab), egg sacs (es), plumes (p) with *Conchoderma virgatum* attached to the end of the abdominal brush (ab). G: Detail of anterior end with head (h), neck (n) and lateral horns (lh). F: Detail of the cephalothorax's head (h) and lateral horns (lh) within the cyst (c). E: Dissected cyst (c) with parasite. head (h), neck (n) and lateral horns (lh). H: Binocular light microscope views of the head (h), single papillae (red circles), central (cr) and lateral (lr) rows of papillae. **Scale bar: 2cm.**

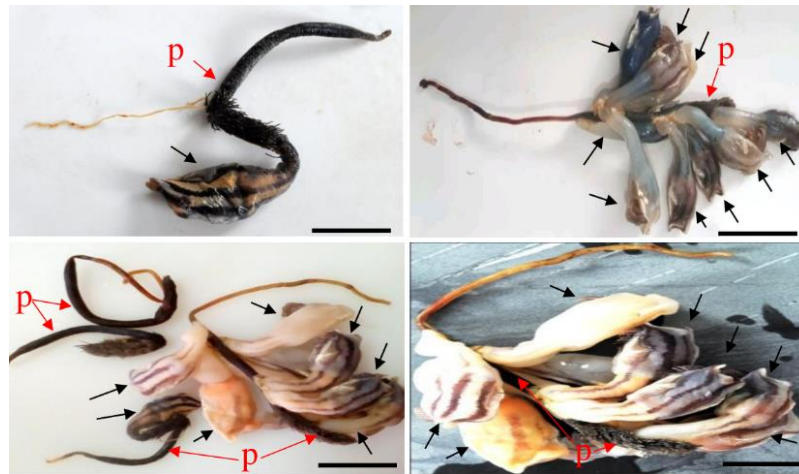


Fig. 3. Recorded association between *Penella instructa* (p) and *Conchoderma virgatum* (see arrows). **Scale bar: 2cm.**

Microscopic examination (histological examination) reveals parasite sections surrounded by necrotic tissue (Fig. 4 A, B). Host's epidermis is enlarged by both growth and movement of the parasite of *X. gladius* (Fig. 4 C, D), and all components of skin were damaged (Fig. 4 E). In the uninfected area of the body of *X. gladius*, all

components of skin were intact (Fig. 4 F). Fibrous cysts were observed as host reaction to the infection by this parasite with the presence of immunological cells. All these damages and injuries may be facilitating and enhance the entrance of many pathogenic agents like bacteria, fungi and viruses.

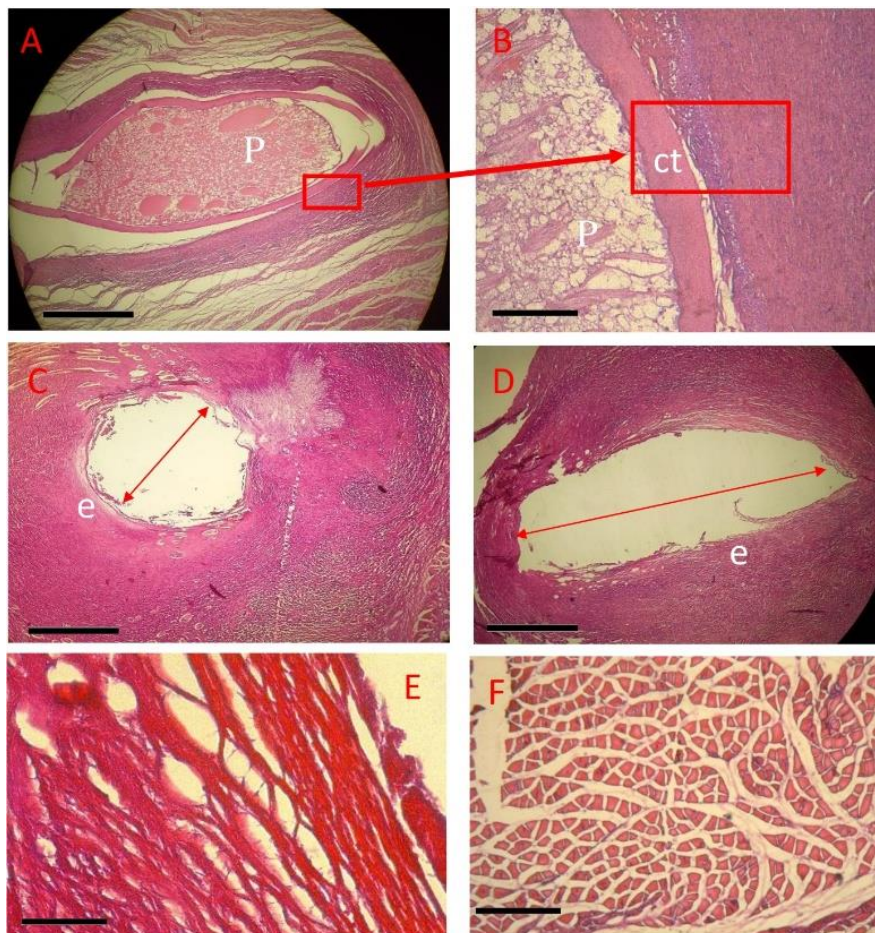


Fig. 4. A, B: section of *P. instructa* (p) surrounded by connective tissue (ct). **C, D:** section of anchor process of *P. instructa* (p) after penetration skin and destruction of the epidermis (e) took place at the site of entrance (red arrow). **E:** damaged skin. **F:** healthy skin. **Scale bar: A, C, D: x4 = 300 μm, B, E, F: x10 = 100 μm.**

DISCUSSION

In the present study, we describe for the first time *Pennella instructa* (and its epibiont *Conchoderma*

virgatum) parasitizing *Xiphias gladius* from Algerian coasts. Studied morphological features of the collected mesoparasites specimens confirm their attachment to the species *Pennella instructa*. Observed morphological features are in accordance with the descriptions given on this parasite by Hogans et al. (1985) and Hogans (1986).

P. instructa was originally reported by Wilson (1917) giving just a general description. Collected specimens of this parasite did not differ from the original description of Wilson (1917), Hogans (1986) and from descriptions of specimens collected by Öktener et al. (2007) and Llarena-Reino et al. (2019) from *X. gladius* and Öktener (2009) from *Seriola dumerili* (Risso, 1810).

The cephalothorax of *P. instructa* passed through the musculature and was surrounded by a cyst. Mattiucci et

al. (2005) and Llarena-Reino et al. (2019) described the same parasitic cyst.

This mesoparasite Pennellid infects many parts of the body surface of its host and does not exhibit a particular specificity to the fixing site and host. In the Mediterranean Sea, *P. instructa* was already known parasitizing *X. gladius* and had been reported previously on the same host by Mattiucci et al. (2005) and Massi et al. (2014) from Italy; Öktener et al. (2007, 2010c) from Turkey and from Algeria (Ramdani et al., 2021) (Tab.2). Nevertheless, this parasite was also collected on other host species like *Seriola dumerili* (Risso, 1810) reported by Öktener (2009).

Table 2.

Collected Pennellids on *Xiphias gladius* Linnaeus, 1758 from different localities of the Mediterranean Sea

| Parasite species | host species | Authors | Locality |
|--|---------------------------------|---|-------------------|
| <i>Pennella filosa</i> (Linnaeus, 1758) | <i>Xiphias gladius</i> L., 1758 | Raibaut et al., (1998) | Mediterranean Sea |
| <i>Pennella instructa</i> (Wilson, 1917) | <i>Xiphias gladius</i> L., 1758 | Öktener et al., (2007) Öktener et al., (2010c) | Turkey |
| | <i>Xiphias gladius</i> L., 1758 | Mattiucci et al., (2005) Mattiuci et al., (2014) Massi et al., (2014) | Italy |
| | <i>Xiphias gladius</i> L., 1758 | Ramdani et al., (2021) Present study | Algeria |

Some collected specimens present a remarkable association with an epizootic species *Conchoderma virgatum* (Spengler, 1790). In some case, we found 8 specimens fixed on the trunk of this mesoparasite especially those having an important body size. *Conchoderma virgatum* (Spengler, 1790) is a species of goose barnacle (Lepadidae). It is a pelagic species found attached to swimming objects or marine organisms seaweed, crabs, sea snakes, turtles and whales, and at least thirteen species of fish and crustacean parasites particularly copepods and isopod (Hastings, 1972). Like most barnacles, *Conchoderma virgatum* is a filter feeder. A number of modified legs known as "cirri" can be extended into the water column. These feathery appendages beat rhythmically and catch plankton and small organic particles, drawing them into the mouth (Ruppert et al., 2004).

Most of conducted studies on this Pennellid (infecting *X. gladius*) focused on the taxonomy and ecology; few were performed on its pathological effect (infection impact). In our study, many damages like mechanic effects, alterations, lesions, and necrosis were observed. Inflammation and fibrous cyst formation were the principal response of the infection.

Many authors reported the pathological effects of this parasite species, Kabata (1979), Hogans et al. (1985); Mattiucci et al. (2014) and Llarena-Reino et al. (2019) reported that these parasites could threat vital functions by harming internal organs such as the heart, aorta or other blood vessels, ovary, intestine or stomach, affect the fitness of the fish host, leading to the reduction of the muscle mass and thus damaging the swimming muscles or compromising their ability to swim. Deterioration of organoleptic properties of the host as

direct consequence of formation of cysts formed in its musculature, often near the vertebral column, may also affect the hosts' nervous system (Lester et al., 1995; Llarena-Reino et al., 2019).

Our results report ulceration and tissue damage in fish. The dermis and musculature were the only sites of attack by *P. instructa* and an inflammatory response was observed. Our results show no infected internal organs. As in our study, Cornaglia et al. (2000) and Danyer et al. (2014) observed a serious inflammatory reaction in the subcutaneous adipose tissue and on the skin of dolphin infected with *Pennella sp.*, and also in the blubber and muscle of *Phocoena phocoena relicta* (Abel, 1905) infected with *Pennella balaenoptera* (Koren and Danielssen 1877).

It is concluded that the *P. instructa* causes ulceration and affects the skin and musculature dermis vaissels hemorrhage bloods. All these damages may be facilitate and enhance the entrance of many pathogenic agents like bacteria, fungi and viruses, enhancing therefore pathologies and impacting the biological potential (May be affect condition reduction of the muscle mass and therefore the biomass) of the infected *X. gladius* (Roberts, 1979; Ramdane et al., 2009 and Ramdane, 2009).

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AUTHORS CONTRIBUTION

S.R.; methodology, data collection, analyses and interpretation of data; Z.R.; supervisor, design of the study and data validation, S.R., Z.R. and J.P.T.; data

processing, S.R.; writing original draft preparation and writing of the manuscript, Z.R and J.P.T.; writing review and editing.

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CONFLICT OF INTEREST

We are Souhila RAMDANI, Jean-Paul TRILLES and Zouhir RAMDANE and declare that we have no conflict of interest.

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