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Parasite of *Gnathia Sp.* in Marine Fishes of the Western Coast of Libyan

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Gnathia sp., Isopoda, infestation, Diplodus annularis, Sarpa salpa, Libya.

ABSTRACT

Isopoda parasites are arthropods that infect different marine fishes, this study was carried out between January 2017 to March 2021, aimed to identify the parasites in some fishes caught from the western coast of Libya, a total of 345 individuals of nine different fishes, were collected from Tripoli coast namely: *Diplodus annularis* Linnaeus, 1758, *Sarpa salpa* Linnaeus, 1758, *Diplodus sargus* Linnaeus, 1975, *Pagellus erythrinus* Linnaeus,1758, *Mustelus mustelus* Linnaeus,1758, *Squalus sp* Risso, 1826, *Sphyraena viridensis* Cuvier, 1829, *Sphyraena sphyraena* Linnaeus, 1758, *Sphyraena flavicauda* Rüppell, 1838. A total of 1011 of praniza larvae *Gnathia sp* were isolated, the highest prevalence of infection was in the *D. sargus* (66.67%) with mean intensity 6.57 and abundance of 23.5 whilst the lowest prevalence was 3.85% in the *S. viridensis* with a mean intensity 1 and abundance 0.038, this study has been provided important information on the impact of parasites on the Libyan coast as well as to fill the gap of knowledge on the parasites diversity along the south Mediterranean.

طفيل *Gnathia sp.* في الأسماك البحرية بالساحل الغربي الليبي

سارة بن زقلام محمد لمين شوهدي عائشة سيف النصر إسماعيل الشقمان

طفيليات الأيزوبودا هي مفصليات الأرجل التي تصيب أنواعًا مختلفة من الأسماك البحرية ، وقد أجريت هذه الدراسة في الفترة من يناير 2017 إلى مارس 2021 ، بهدف التعرف على الطفيليات في بعض الأسماك التي تم اصطيادها من الساحل الغربي لليبيا ، وتم جمع ما مجموعه 345 فردًا من تسعة أسماك مختلفة. من ساحل طرابلس وهي: ديبلودوس أنولاريس لينيوس ، 1758 ، ساربا سالبا لينيوس ، 1758 ، ديبلودودوس سارجوس لينيوس ، 1975 ، باجيلوس إريثرينوس لينيوس ، 1758 ، موستيلوس موستيلوس لينيوس ، 1758 ، سكوالوس سب ريسو ، 1826 ، سبيرايا فيريدنسيس ، لينيوس ، 1826 ، 1758، Sphyraena flavicauda Rüppell، 1838 .تم عزل ما مجموعه 1011 من يرقات البرانيزا Gnathia sp ، وكان أعلى انتشار للعدوى في (66.67٪) D. sargus بمتوسط شدة 6.57 ووفرة 23.5 بينما كان أقل انتشار 3.85 ٪ في S. viridensis بمتوسط كثافة 1 ووفرة 0.038 ، قدمت هذه الدراسة معلومات مهمة عن تأثير الطفيليات على الساحل الليبي وكذلك لسد فجوة المعرفة حول تنوع الطفيليات على طول جنوب البحر الأبيض المتوسط.

INTRODUCTION

The Isopoda is small crustaceans, approximately 4,500 marine isopod species are known in the world's ocean, they are distributed worldwide mostly on the sea bottom from the abyssal depths and continental shelf to the intertidal zone and with only a few representatives in the pelagic zone (Tanaka, 2007; Ferreira *et al*., 2010; Jayanthi *et al*., 2017). One of the marine isopod species is the family Gnathiidae, which includes about 200 species belonging to 12 genera (Jayanthi *et al*., 2017). Gnathiids live as external fish parasites and freely swim to attach the skin, fins, gills and mouth cavity of infest teleosts and/or elasmobranch fish and it starts living as larvae on the fish without feeding called “zuphea” and next

becomes sucking their blood and body tissue fluids during their larval stage called "praniza" with a clearly distended, abdomen that cause the reduce of the haematocrit of the host or even cause it's death, (Zander *et al*., 1994; Heupel and Bennett 1999; González *et al*., 2004; Marino *et al*., 2004; Diniz *et al*., 2008; Overstreet *et al*., 2009; Shodipo *et al*., 2019). No morphological differences were found between the zuphea and praniza stages, except that in the praniza stages the elastic membrane between pereonites 3 and 6 was fully stretched due to the presence of the blood meal in the anterior hindgut (Smit, 2002). Later in the adult stage are non-feeding and it becomes living in coral rubbles, sponges or sediment cavities (Smit and Davies 2004; Genc *et al.*, 2005; Yuzo Ota, 2011). The morphology of gnathiid larvae differs from the adult stage of this gnathiid by needle-like mouthparts larvae has for sucking fish body fluids but the adult stage of male possesses the elongated mandibles, whereas the adult females lack mandibles and have a swollen thorax for brooding (Ota, 2013). The description of the *gnathia* species are depended almost exclusively on the morphology of the adult males gnathiid and the females are extremely difficult to identify to species (Williams, and Williams, 1996; Ota, 2013; Jayanthi *et al*., 2017; Hadfield *et al*., 2019). Marine gnathiid isopods have a biphasic life cycle. (Genc *et al.*, 2005). The recorded life cycles in different es of fish are all very similar and differ mainly in the length of the cycle as well as the different host species, for example, the South African gnathiid isopod, *Gnathia pilosus* may 2nd and 3rd of the unfed larval stages (zuphea stage) took an average of 3 hours 52 minutes and 4 hours 19 minutes to feed respectively, after feeding, the second stage fed larvae (praniza 2) took 35 days to moult into the 3rd zuphea form. Male and female praniza 3rd stage of larvae could be discerned before their final moults into adults which took place approximately 42 and 48 days respectively after their blood meals, fertilization occurred within 24 hours after the female had completed her moult (Jayanthi *et al., 2017*). It was thus estimated that the complete life cycle from the first larval stage to adult took between 134 to 140 days in water temperatures ranging between 20^{0}C and 25^{0}C (Hadfield *et al*., 2009). The importance of this research lies in the process of isolating and defining external parasites for nine different species of fish, and trying to contribute to building a database in Libyan coast, the aim of this study is to survey the prevalence of *gnathia* sp. in some different fishes caught from western coast of Libya.

MATERIALS AND METHODS

A total of 345 individuals of nine different fishes belonging to three different families of fish (Annular sea bream) *D. annularis*, (Salema) *S. salpa*, (White sea bream) *D. sargus*, (Common Pandora) *P. erythrinus*, (Smoothhound) *M. mustelus* and (longenose spurdog) Squalus *sp* (Risso, 1826), (the yellowmouth barracuda) *S. viridensis*, (Mediterranean barracuda) *S. sphyraena*, (The yellowtail barracuda) *S. flavicauda*, were collected from January 2017 to November 2021. The fish were classified and named according to (Golani *et al*., 2006). The fishes were transported inside the ice box directly to the laboratory of the Biology Department at the Faculty of Education and Science at the University of Tripoli. After taking the necessary biological measurements such as length to nearest ±0.1mm and weight to nearest ±1 g, the body surface was cleaned with a distal water and then the body, fins, gills and mouth cavity of each fish were examined morphologically. The gills removed outside of body fish and put it in the petri dish contained on distal or filter sea water and examined under dissecting microscope. Isolated Parasites were fixed in 70% ethanol and later examined under the dissecting microscope and also, stereomicroscope for identification (American Optical Microscope), the photos captured by microscopic digital camera OMAX A35180U3 and smartphone. The identification of parasites were completed according to various authors (Möller and Anders, 1986; Lawrence and Keast 1990; Smit *et al*., 1999). The prevalence intensity and abundance were measured according to Bush *et al*. (1997).

RESULTS

In this study, the praniza larvae of *Gnathia* sp. was isolated (Figs. 1, 2, 3) from the 9 different fishes, a total 345 individuals of examined fish, the number of infected fish was 62, with prevalence of infestation 18%, the mean intensity 17.75 per fish and abundance 3.19. The parasites were found only in the gill chamber, fins and mouth cavity with expanded anterior hindgut filled with host blood, attached to the gill filaments with the mouthparts.

The highest prevalence of infection was in the *D. sargus* (66.7%) with mean intensity 35.2 and abundance 23.5 and the lowest prevalence was in

the *viridensis* (3.85) with mean intensity 1 and abundance 0.33, while did not isolate this species of parasite from *M. mustelus* and *S. blainvillei*.

Table 1. Biometric and parametric data of the fishes captured from western coast of Libya

Fishes	*Diplodus annularis*	*Sarpa salpa*	*Diplodus sargus*	*Pagellus erythrinus*	*Mustelus mustelus*	*Squalus sp*	*S. viridensis*	*S. sphyraena*	*S. flavicuda*
Total length(cm)	**12.2 - 20**	**11 – 30.5**	**12.4 – 26.6**	**19.4 - 26.7**	**77 – 42**	**65 - 45**	**31 - 62**	**29 - 48**	**24 - 40.2**
Weight(g)	**118 – 32**	**422 - 125**	**362 - 125**	**254 – 94**	**1,426 – 318**	**1,334-500**	**862 - 139.5**	**97 - 149**	**84 - 131**
No. of fish	**40**	**30**	**42**	**40**	**25**	**20**	**52**	**50**	**46**
No. of infected fish	**6**	**6**	**28**	**7**	**N.R.**	**N.R.**	**2**	**3**	**10**
No. of parasite	**9**	**38**	**988**	**46**	**N.R.**	**N.R.**	**2**	**4**	**14**
Prevalence %	**15**	**20**	**66.67**	**17.5**	**N.R.**	**N.R.**	**3.85**	**6**	**21.74**
Abundance	**0.23**	**1.27**	**23.5**	**1.15**	**N.R.**	**N.R.**	**0.038**	**0.08**	**0.30**
Mean intensity	**1.5**	**6.33**	**35.29**	**6.57**	**N.R.**	**N.R.**	**1**	**1.33**	**1.4**

None recorded

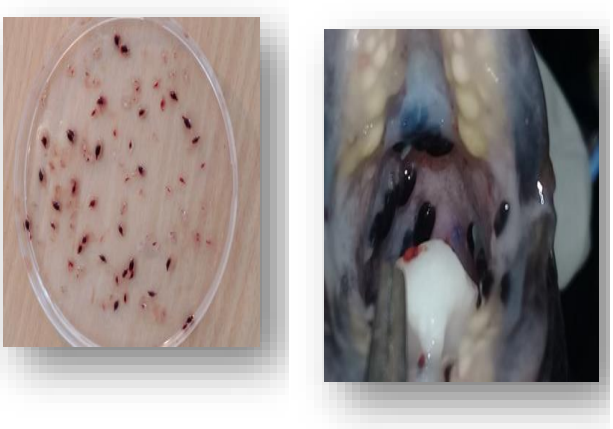

Fig 1. Praniza larvae in the mouth of *Diplodus sargus* in the western coast of Libya

Description of praniza larvae

Total length of material examined varies from 1.97 – 3.46 mm, thorax of live specimen dark red or brown, white margin parts are light brown or white. The first section consists of the cephalosome (including the antennae and the mouthparts). The second section was a peraeon with five pairs of peraeopods. The third section was a pleon with five pairs of pleopods and the forth section was a telson with one pair of uropods. It had straight and parallel lateral margins. The eyes were oval-shaped and located on the lateral margins of the cephalosome, and the length of the eye is more or less half of the length of the cephalosome. It's considered cephalosome was the first articles of the antennae. It had straight antennae, the antenna 1 being shorter than the antenna 2.

Fig 2. *Gnathia* sp (dorsal view). (C) cephalon. (P) Pereon. (PL) Pleon. (T) Telson. (E) Eyes. (A) Antenna. (UR) Uropod

First Antenna has three pedunculate articles. The flagellum has four articles, of which article 2 is the largest and articles 2 and 3 have one aesthetasc seta, and article 4 ends in one aesthetasc seta and two simple setae. Article 2, 3 and 4 presented few setae. Antenna 2 had four pedunculate articles, the fourth of which is the largest. The flagellum has seven articles, of which article 1 is the largest, article 7 ends in three or four simple setae, and few setae exist on the distal end of each article. The labrum was distinguished and semicircular, with an apical process, and its posterior and anterior margins are concave. The gnathopods were smaller than the peraeopods, have seven articles, the dactylus was hooked, and they present a few simple setae. The paragnaths were prolonged and end in sharp points, presenting no teeth. The maxillules were long and thin, exceeding the distal margin of the labrum.

Fig 3. Different stages of Praniza larvae of *Gnathia sp* in different hosts

Discussion

It's important to know the species of parasites that are exist in Libyan waters and infect their fish, and to register them in the marine biodiversity database. Since there are no scientific studies in which isopods parasites were recorded in Libyan water fish, a research team conducted this study, which resulted in the first recording of the praniza larvae of the *Gnathia* sp. The prevalence of infestation was 15% in the *D. annularis* , 20% in the *S. salpa*, 66.7% in the *D. sargus* and 17.5% in the *P. erythrinus*, but these larvae were absent in the *Mustelus.* and *Squalus blainvillei* of the Libyan territorial waters, south of the Mediterranean. The research team tried to search for studies or scientific papers through which the *Gnathia* sp. isopoda parasites of Libyan fish were recorded, so that we can compare them with what the current study concluded, but unfortunately there were no papers or studies. There are various studies about *Gnathia* sp. have been done, especially in Mediterranean Sea (Alas *et al*., 2009), the Smit and Basson (2002) were collected the *Gnathia* sp. isopoda from gills, nares and buccal cavity of a *Poroderma pantherinum* (Smith, 1838) at Jeffreys Bay and five *Haploblepharus edwardsii* (Voight, 1832) and one *Torpedo fuscomaculata* Peters, 1855, at the De Hoop Nature Reserve on the South African south coast. González *et al*. (2004) were isolated the *Gnathia* sp. praniza larvae from the dusky grouper population within Iskenderun Bay, northeast Mediterranean Sea. Also, Diniz *et al*. (2008) found the infection of the estuarine teleost fishes *Mugil gaimardianus*, *Arius phrygiatus*, *Conodon nobilis*, *Cetengraulis edentulus* and *Anableps anableps* by praniza larvae with the highest prevalence of infection in *Anableps anableps* (42.3%), the specimens fished off from Atlantic Ocean in Northeast of Pará State, near Braganza, Brazil. Isolated of the *Gnathia* sp. from the mouth cavity and gill filaments of the different species of fish including *S. salpa* with prevalence of infection 75% (MI= 2.6 and A= 8) and *P. erythrinus* with prevalence 26% (MI= 3 and A= 21) of the Marmara Sea, the Black Sea and the Aegean Sea (Ali *et al*., 2009). The Ota (2011) was described a new species of gnathiid isopod, *Gnathia teruyukiae* which parasitized elasmobranch fish caught from off Okinawa Island, Ryukyu Islands. Boualleg *et al*. (2012) were recorded the *Gnathia* sp. isopoda from gills of twelve species of the Eastern Algerian coastline including *D. sargus* with prevalence 16.66% (I= 2.3 and A=0.38), *D. annularis* (P= 13.33%, I= 2.25 and A= 0.3), *S. salpa* (P= 5, I= 5 and A= 0.05) and *P. erythrinus* (P= 4.44, I= 1.5 and A= 0.06). This results differed with what was concluded in the current study, where it was found that the prevalence in *S. salpa* was 20% and 17.5% in the *P. erythrinus* The reason for this difference may be due to the geographical distribution, such as the difference in the physicochemical factors of the water, or perhaps as a result of the abundance or lack of food or the appropriate conditions for this parasites. In addition to study of Svavarsson and Bruce (2012) Ten species of Gnathiidae including six new species, are reported from Lizard Island and nearby reefs, northern Great Barrier Reef and reefs of the Coral Sea (Chesterfield Reefs, Mellish Reef and Marion Reef). There is only one published record of the isopod *Gnathia* sp. from one fish species from the Yemeni coast of the Red Sea (Al-Zubaidy and Mhaisen, 2013). Jassim (2013) were reported the *Gnathia* sp. praniza larvae from gills of the *Acanthopagrus arabicus* of the coastal marine waters of the Arab Gulf. Also, Adday (2013) recorded the same praniza larvae from the gills of 18 fish species (including *Diplodus sargus*) from the coastal marine waters of the Arab Gulf. The André (2013) recorded the praniza larvae of the *Gnathia* sp. from the *Diplodus sargus* by prevalence of infection 17.4%. mean intensity 1.5 and abundance 0.26. the Hispano *et al*. (2014) were reported the *Gnathia maxillaris* form five fish species including *Diplodus sargus* of the Barcelona. Another study conducted by Jayanthi *et al*. (2017) who were isolated the praniza larvae of the *Gnathia* sp. isopoda from gill chambers of *Heniochus acuminatus* with prevalence of infection 13.9% and mean intensity 17. They were collected from the Gulf of Mannar region, Southeast coast of India.

Gnathia sp. Larvae have been collected from native and exotic barracuda fish where they belong to the Gnathidae family was only at the praniza stage. Gnathiid isopods are unique parasites in fish; only juvenile life stage is parasitic and feed on host blood,

lymph or mucus, while adults are free-living, non-feeding (benthic organisms) (Smit and Davies, 2004). This marine isopod is worldwide distribution, have been found in Antarctic to the Arctic, but mostly in warm (tropical) areas where they have been reported. it is very common in the Mediterranean and Libyan coast, which presence on the commercial fish and crustaceans, as well as causing lesions that would represent access to viruses and bacterial infection (Grutter, 1994). In addition, they have also been detected in the diet of fish from Portugal, Brazil, aquariums in the United Kingdom, Spain, Puerto Rico, Bahamas and Panama (Grutter *et al*., 2002). Hence, it is important to understand the ecology of the Gnathid in order to understand the cleaning behaviour. Praniza are often found on fish and feed on fish parasites at the larval stage, then return to the benthos to digest their blood meal to develop into the next stage, they have 3 larval stages (Monod, 1926; Wagele, 1987; Grutter and Poulin 1998; Sikkel *et al*., 2000; Arnal and Morand, 2001).

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References

Adday, T.K. (2013). Parasitic crustaceans of some marine fishes of Basrah province, Iraq. Ph. D. Thesis, College of Agriculture, University of Basrah, 302 pp.

Alas, A., Oktener, A. and Yilmaz, M., (2009). *Gnathia* sp. (Gnathiidae) Infestations on Marine Fish Species from Turkey. Kafkas Univ Vet Fak Derg. 15(2):201-204p.

Al-Zubaidy, A.B. and Mhaisen, F.T. (2013). The First Record of Three Cymothoid Isopods from Red Sea Fishes, Yemeni Coastal Waters. International Journal of Marine Science. Vol.3, No.21, 166-172.

André, F. R. B. (2013). Pesquisa de parasitas em sargo (Diplodus sargus) da costa portuguesa. Faculdade De Ciencias. Univesidade Do Porto.

Arnal, C., Côté, I. and Morand, S. (2001) . Why clean and be cleaned? The importance of client ectoparasites and mucus in a marine cleaning symbiosis. *Behavioral Ecology and Sociobiology*, *51*(1), 1-7.

Boualleg, C., Kaouachi, N. and Bensouilah, M. (2012). L'infestation de douze espèces de Sparidae par le parasite *Gnathia* sp. (Isopoda: Gnathiidae) dans le littoral est-algérien. Bulletin de l'Institut Scientifique, Rabat, section Sciences de la vie. n° 34 (1), p. 65-70.

Chambers, SD. and Sikke, P.C .2002. Diel emergence patterns of ecologically important, fish-parasitic, gnathiid isopod larvae on Caribbean coral reefs. Caribb J Sci 38:37–43.

Diniz, D.G., Varella, J.E., Guimarães, M.D.F., Santos, A.F., Fujimoto, R.Y., Monfort, K.C., Pires, M.A., Martins, M.L. and Eiras, J.C., 2008. A note on the occurrence of praniza larvae of Gnathiidae (Crustacea, Isopoda) on fishes from Northeast of Pará, Brazil. Anais da Academia Brasileira de Ciências, 80(4), pp.657-664.

Ferreira, M.L., Smit, N.J. and Davies, A.J., 2010. Gnathia grutterae sp. nov. (Crustacea, Isopoda, Gnathiidae) parasitising representatives of the Balistidae, Labridae and Tetraodontidae from Lizard Island, Great Barrier Reef, Australia. Zootaxa, 2718(1), pp.39-50.

Genc, E., 2007. Infestation status of gnathiid isopod juveniles parasitic on Dusky grouper (Epinephelus marginatus) from the northeast Mediterranean Sea. Parasitology research, 101(3), pp.761-766.

Genc, E., Genc, M.A., Can, M.F., Genc, E. and Cengizler, I., 2005. A first documented record of gnathiid infestation on white grouper (*Epinephelus aeneus*) in Iskenderun Bay (north‐eastern Mediterranean), Turkey. Journal of Applied Ichthyology, 21(5), pp.448-450.

González, P., Sánchez, M.I., Chirivella, J., Carbonell, E., Riera, F. and Grau, A., 2004. A preliminary study on gill metazoan parasites of Dentex dentex (Pisces: Sparidae) from the western Mediterranean Sea (Balearic Islands). Journal of Applied Ichthyology, 20(4), pp.276-281.

Grutter, A. S. (1994). Spatial and temporal variations of the ectoparasites of seven reef fish species from Lizard Island and Heron Island, Australia. *Marine Ecology Progress Series*, *115*, 21-30.

Grutter, A. S. and Poulin, R. (1998). Intraspecific and interspecific relationships between host size and the abundance of parasitic larval gnathiid isopods on coral reef fishes. *Marine Ecology Progress Series*, *164*, 263-271.

Grutter, A. S., Deveney, M. R., Whittington, I. D. and Lester, R. J. G. (2002). The effect of the cleaner fish Labroides dimidiatus on the capsalid monogenean Benedenia lolo parasite of the labrid fish Hemigymnus melapterus. *Journal of Fish Biology*, *61*(5), 1098-1108.

Hadfield, K.A., Schizas, N.V., Chatterjee, T. and Smit, N.J. 2019. *Gnathia bermudensis* (Crustacea, Isopoda, Gnathiidae), a new species from the

mesophotic reefs of Bermuda, with a key to Gnathia from the Greater Caribbean biogeographic region. ZooKeys 891: 1–16.

Hadfield, K.A., Smit, N.J. and avenant-oldewage, A. 2009. Life cycle of the temporary fish parasite, *Gnathia pilosus* (Crustacea: Isopoda: Gnathiidae) from the east coast of South Africa. Journal of the Mar Biol Associ of the Unit King. 89 (7), 1331–1339.

Heupel, M.R. and Bennett, M.B., 1999. The occurrence, distribution and pathology associated with gnathiid isopod larvae infecting the epaulette shark, Hemiscyllium ocellatum. International Journal for Parasitology, 29(2), pp.321-330.

Hispano, C., Bultó, P. and Blanch, A.R. 2014. Life cycle of the fish parasite *Gnathia maxillaris* (Crustacea: Isopoda: Gnathiidae). Folia Parasitologica 61 [3]: 277–284.

Jassim, A.A.R. 2013. Disease agents of *Acanthopagrus latus* (Houttuyn, 1782) (Sparidae, Perciformes) and some species of penaeid shrimps from Iraqi coastal waters, Basrah, Iraq. Ph. D. Thesis, College of Agriculture, University of Basrah. 127 pp.

Jayanthi, G., Anand, M., Chelladurai, G. and Kumaraguru, A.K. 2017. First record of *Gnathia* sp. an ectoparasitic isopod isolated from the coral reef fish, *Heniochus acuminatus* collected from the Gulf of Mannar region, southeast coast of India. J Parasit Dis, 41(1):188–192.

Lawrence, M.J. and Keast, M.A., 1990. A Guide to Identification of Benthic Isopoda from the Southern Beaufort Sea. Department of Fisheries and Oceans, Central and Arctic Region.

Marino, F., Giannetto, S., Paradiso, M.L., Bottari, T., De Vico, G. and Macri, B. 2004. Tissue damage and haematophagia due to praniza larvae (Isopoda: Gnathiidae) in some aquarium seawater teleosts. Dis Aquat Org 59: 43–47.

Möller, H. and Anders, K. 1986. Diseases and Parasites of Marine Fishes. Verlag Heino Möller, Kiel.

Monod, T. (1926). Les Gnathiidae. Essai monographique (morphologie, biologie, systématique). *Mémoires de la Société des Sciences naturelles du Maroc*, *13*, 1-668.

Ota, Y. 2011. A New Species of the Gnathiid Isopod, *Gnathia teruyukiae* (Crustacea: Malacostraca), from Japan, Parasitizing Elasmobranch Fish. Bull. Natl. Mus. Nat. Sci., Ser. A, Suppl. 5, pp. 41–51.

Ota, Y. 2013. Redescription of five gnathiid species from Japan (Crustacea: Isopoda). Zootaxa 3737 (1): 033–056.

Shodipo, M.O., Gomez, R.C., Welicky, R.L. and Sikke, P.C. 2019. Apparent kleptoparasitism in fish—parasitic gnathiid isopods. Parasitology Research. 118:653–655.

Sikkel, P. C., Fuller, C. A. and Hunte, W. (2000). Habitat/sex differences in time at cleaning stations and ectoparasite loads in a Caribbean reef fish. Marine Ecology Progress Series, 193, 191-199.

Smit, N. J. and Davies, A. J. (2004). The curious life-style of the parasitic stages of gnathiid isopods. *Advances in parasitology*, *58*, 289-391.

Smit, N.J. and Basson, L., 2002. Gnathia pantherina sp. n. (Crustacea: Isopoda: Gnathiidae), a temporary ectoparasite of some elasmobranch species from southern Africa. Folia Parasitologica, 49(2), pp.137-151.Smit, N.J. and Basson, L. 2002. *Gnathia pantherina* sp. n. (Crustacea: Isopoda: Gnathiidae),

Smit, N.J., Van A.s, J.G. and Basson, L. 1999. A redescription of the adult male and larvae of Gnathia africana Barnard, 1914 (Gnathiidae: Crustacea: Isopoda) from Southern Africa. Folia Parasit, 46, 229-240.

Svavarsson, J. and Bruce, N.L. 2012. New and little-known gnathiid isopod crustaceans (Cymothoida) from the northern Great Barrier Reef and the Coral Sea. Zootaxa 3380: 1–33.

Tanaka, k. 2007. Life history of gnathiid isopods–current knowledge and future directions. Plankton Benthos Res 2(1): 1–11.

Wägele, J. W. (1987). Description of the postembryonal stages of the Antarctic fish parasite *Gnathia calva Vanhöffen* (Crustacea: Isopoda) and synonymy with Heterognathia Amar & Roman. Polar Biology, 7(2), 77-92.

Williams, E. and Williams, L. 1996. "Parasites of offshore big game fishes of Puerto rico and The Western Atlantic". Department of Biology University of Puerto Rico. P.O. Box 5000, pp. 338.