

First Report of *Pennella balaenopterae* Infestation in a Fin Whale (*Balaenoptera physalus*) Carcass Washed Ashore on the Israeli Coastline

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ABSTRACT

This case report describes the first identification in Israel of the mesoparasitic copepod *Pennella balaenopterae*, in the carcass of a marine mammal. A Fin whale (*Balaenoptera physalus*) washed ashore on the Israeli coast was autopsied in contiguity to a large oil spill that occurred along Israel's coastline. At the external examination, a large number of *Pennella balaenopterae* were embedded within the whale's blubber on its ventral and lateral sides. Further toxicological analyses of lung and bronchus samples, revealed the presence of higher-than-acceptable levels of toluene without any evidence of other above-normal petroleum components, suggesting the inhalation of the substance. This paper proposes to consider toluene toxicity as a possible etiological factor affecting the host's immunity and consequently increasing the parasitic pressure.

Keywords: *Pennella balaenopterae*; Toluene toxicity; Fin Whale; Parasitic Copepod.

INTRODUCTION

Pennella balaenopterae is a member of the order Siphonostomatoida, family Pennellidae, and genus *Pennella* (1, 2). It was initially described by Koren and Danielssen in 1877(3), and is the only mesoparasitic copepod known to infest marine mammals (1, 4, 5). This integument-semi-buried, pan-globally distributed (5), parasite was previously identified in dolphins (Delphinidae) (4, 6), baleen whales (Balaenopteridae) (1, 7-10), and occasionally in pinnipeds (11) and porpoises (12).

P. balaenoptera is the largest copepod (1, 4, 5), and appears as a filament hanging from the skin. Although this parasite has been recognized for more than a century, its exact life cycle remains greatly unknown (4, 8), and currently, only the

adult female and the first naupliar stage have been firmly recognized (2, 5, 9, 13). The external morphological regions of the adult female are: cephalothorax, holdfast horns, neck, trunk and abdomen (5).

Under normal conditions, pennellid infestation is rather limited to solely a few organisms per host, yet, an elevated number of *P. balaenopterae* could be seen as indicators of more severe underlying health conditions (e.g. immune suppression) (4, 6).

In his review article, Hogans (2017) validated or potentially validated 15 of 44 members of the genus *Pennella* according to their morphological character and their non-morphological character based on the infested host (5). However, a study conducted by Fraija-Fernández *et al.* (2018) found that *P. balaenopterae* and *P. filosa* (a species known to



Figure 1: Fin whale (*Balaenoptera physalus*) washed ashore Israeli coastline on February 18th, 2021, prior to necropsy

infest fishes) did not present with significant molecular differences between both, suggesting a con-specificity (14, 15).

CASE REPORT

On February 18th, 2021, a carcass of a young, male Fin whale (*Balaenoptera physalus*) was washed ashore at Nitzanim beach (34.5882:31.7255) (Figure 1). Earlier that week a large oil spill was caused by the leaking of more than 1000 tons of tar, from a tanker sailing to Syria, resulting in numerous dead marine animals and seabirds (16-18). The proximity of the events raised questions regarding the cause of death.

The whale's necropsy was carried out on February 21st by Kimron Veterinary Institute (KVI) pathology department team and the Israel Nature and Parks Authority (INPA) veterinarian.

GROSS PATHOLOGY

The whale's carcass measured around eighteen meters (59 feet) long and the cadaver's condition was estimated between

3 and 4 according to the "Right whale necropsy protocol" (19).

The carcass was positioned on its dorsal side. At the external examination of the body, on the ventral and lateral parts of the integument, numerous, long tubular structures, consistent with a pennelid copepod neck were embedded within the whale's blubber. When gently extracted, a parasitic cephalothorax consisting of a small, rounded, and bulbous head with two to three long anchoring, holdfast horns (Figure 2) was noticed. These morphological features were consistent with *P. balaenopterae* (4), and the current article describes the first report of this parasitic crustacean along Israeli shores.

The presence of the parasites was the only significant finding observed during the necropsy due to the advanced autolytic state of the carcass.

LABORATORY EXAMINATIONS

A dozen partial parasites were sampled and submitted for further morphological and molecular investigation by



Figure 2: A *Pennella balaenoptera* with its cephalothorax (composed of a small bulbous head and three horns) and a long tubular neck, positioned on top of the ventral integument.

the KVI parasitology department. The parasites were preserved in a 10% neutral buffered formalin (NBF) and a PCR test targeting the mitochondrial cytochrome c oxidase subunit I gene (*COI*) of metazoan invertebrates (20) was performed.

Samples of lung, bronchus, urine, and blood were submitted for targeted toxicological analyses for identification of

traces of volatile organic compounds (VOCs) related to oil spill. The laboratory evaluated the following markers: hexane, heptane, octane, decane, undecane, dodecane, tetradecane, benzene, toluene, m-xylene, o/p-xylenes, and ethylbenzene, cyclohexane and, naphthalene.

RESULTS

The parasitology department of the KVI identified the meso-parasitic copepod *P. balaenopterae* by means of morphological identification (4, 5, 7) and host specificity (5) since molecular analyses identified only whale's DNA (14, 20).

Morphologically, the anterior a of the parasite began with the cephalothorax, which consisted of a small, bulbous head followed by two to three holdfast horns (Figure 3), two lateral, cylindrical, unbranched, and variably-sized and a single, partially present, short dorsal horn. The last visible segment was the neck, which in some cases measured about 14 cm. Based on their morphological appearance and host (marine mammal), the parasites were identified as *P. balaenopterae* (Figure 4) (1, 5).

As for the toxicology results, the levels of all targeted VOCs were similar, comparable and below 0.1 ng/g in whale and control samples (commercial fish samples) with



Figure 3: Parasite fragment containing the cephalothorax and holdfast horns.



Figure 4: Three *Pennella balaenoptera* analyzed by the parasitology department at the KVI.

exception of toluene. Higher concentrations of toluene were detected in the whale's bronchus (0.781-1.417 ng/g) and lungs (0.154-0.157 ng/g), in four samples. This finding could indicate the inhalation of petroleum vapors by the whale.

DISCUSSION

This mesoparasitic copepod has been previously described in marine mammals such as Fin whales (*Balaenoptera physalus*) (7, 10), Striped dolphins (*Stenella coeruleoalba*) (4, 6) and one Harbour porpoise (*Phocoena phocoena*) (12) in the Mediterranean Sea coast lines of Italy (10), Spain (4, 6, 14), Türkiye (7, 12), and Croatia. However this is the first time that this mesoparasitic copepod, *Pennella balaenopterae*, has been identified off the coast of Israel.

During the external examination of the whale's necropsy, numerous parasites were observed; an exact number could not be obtained due to technical limitations. However, previous studies have assessed and established the relation between the mental status of a host and the degree of infestation with *P. balaenopterae* (4, 6).

In this case elevated toluene levels were detected. Toluene is a clear, colorless and low to moderate water-soluble component that is found in different solvents and gasoline (21). Usually, it is rapidly weathered but in stagnant and chronically polluted waters it becomes toxic (22). In both humans and animals, the primary target organ for toluene toxicity is the central nervous system (21, 23). Since crude oil contain a mixture of different hydrocarbons and liquid organic compounds, usually an elevated toluene concentration is detected along with the excess of other similar mono-aromatic hydrocarbons (benzene, xylenes, and ethylbenzene) (24), which in this reported case, were not above the regular levels.

In light of these findings, we recommend further research regarding toluene toxicity as a possible underlying etiological factor, able to affect the mentality and immunity of marine mammals, and consequently increase the parasitic pressure.

ACKNOWLEDGMENTS

The authors wish to thank Julius Ben-Ari for his thorough toxicological report.

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