Results of health surveys of two species of farmed tuna: southern bluefin tuna (Thunnus maccocyii) in Australia and northern bluefin tuna (Thunnus thynnus) in the Mediterranean

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Abstract
Health of two farmed species of tuna was evaluated in farm surveys in Australia, Croatia and Spain. The results were discussed at tuna health workshop during EAFP 12th International Conference. While a wide range of parasites was found, few problems occurred during the surveys. The information obtained will be useful for future monitoring and research on health of farmed tuna.

Introduction
Fisheries of two major species of tuna: Northern Bluefin Tuna (Thunnus thynnus) and Southern Bluefin Tuna (T. maccocyii) are based mostly on grow-out of the wild fish in cages in the sea for about 6-12 months. This process was initiated by introduction of quotas and the potential to gain a higher return from farmed fish (because of their increased weight and enhanced condition). In the Mediterranean region, there are two types of tuna farming depending mainly on the catch size of bluefin tuna. The well-known tuna fattening process is based on the catch of adult and large specimens over 80 kg that will be fattened for 6-10 months; the second type of tuna farming involves the catch of small tuna up to 15 kg, and lasts 1.5-2.5 years, these fish are reared up to 80 kg and fed on imported frozen baitfish and to a lesser extent on local baitfish. The former type of tuna farming is employed by most Mediterranean countries involved in tuna commercial or experimental farming - Spain, Portugal, Malta, Italy, Turkey, Cyprus, Morocco, Tunis and Libya. The latter procedure is found only in Croatia and one Italian farm, as only very small tuna are caught in the Adriatic Sea. In Australia, Southern Bluefin Tuna are fattened for 3-9 months on frozen baitfish. While information on tuna diseases has been reviewed (Munday et al 2003), little information is available in the literature on the current health status of farmed tunas. The aim of this paper is to summarise results of recent health surveys carried out on farmed tuna.

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Materials and methods
Health surveys were undertaken in the Mediterranean and Australia. Prevalence was determined as the percentage of fish infected and abundance as number of parasites per fish (all fish, including uninfected fish).

NBT in Croatia
The survey of Croatian bluefin tuna health started in December 2002 and it has been limited to sampling during the transfer of the fish to their cages, the harvest period and occasional outbreaks of mortalities, which usually have a seasonal character. One farm in the central Adriatic and three farms in northern Adriatic were sampled. During the harvest and transfer visceral organs, kidney and gills were sampled. Brain examination and screening for Uronema sp. were included only in the mortalities investigation. Organs were examined fresh. The sampling took place each year during the harvest period (December - February), during the mortalities (April - July) and when fish were transferred to the cages (June - August). The size of fish depended on the sampling time - at transfer they were, usually from 7 to 15 kg, at harvest 30 to 80 kg and during mortalities from 15 to 35 kg.

NBT in Spain
Hearts, livers, kidneys, and gills of 26 farmed northern bluefin tuna were examined for the presence of Cardicola forsteri adults and eggs as well as for any other parasites. The fish were from an experimental farm, 62 to 118 kg weight, and were sampled in 2004.

SBT in Australia
The tuna health survey started in 2003 (Deveney et al., 2005). As parasites were identified as the main health risk for SBT (Nowak, 2004), the survey has focused on parasite loads in harvest fish and mortalities. Commercial and experimental samples are included in the survey. So far 1543 harvest fish and 85 mortalities have been examined. Routine examination covers gill parasites, screening for Cardicola forsteri and in most fish examination of internal organs (except kidney) for parasites. Targeted screening for Uronema nigricans or Caligus elongatus has been undertaken when these parasites were suspected to be an issue. This survey has not included examination of intestinal lumen and mucosa. Only a few gall bladders and bile samples were checked for coelozoic myxozoans. Other aspects of tuna health, such as histopathology, microbiology and immune response are addressed by preliminary studies.

Results and discussion
A range of parasites was found in cultured tuna during health surveys (Table 1). Some appeared to be unique to region or species, for example the ciliate Uronema nigricans, the cause of swimmer syndrome, was reported only from Australia. However, several parasites, of at least the same genus if not species, were present in both tuna species: from the Mediterranean and Australia. These included Hexostoma sp., Cardicola forsteri and Pseudocycnus appendiculatus (Table 1).

In Australia most parasites were present on tuna each year, although the prevalence and intensity of infection differed, particularly for the copepod Caligus elongatus and ciliate Uronema nigricans. In Croatian tuna farming there was considerable annual variation in
parasite presence and abundance. Once the fish were adapted to cages, their parasite fauna declined both in prevalence and abundance. For example, in Croatia some 50% of young tuna regularly host the nematode *Oncophora melanocephala*, attached deeply in pyloric caeca mucosa. However, their abundance was only 1.74 parasites/fish and soon after transfer to the cages, the parasite was lost from the tuna population and thus is not regarded as a serious threat to the health of farmed tuna.

In Croatian tuna rearing there were no mortalities induced or even exacerbated by parasites. In Australia, *Uronema nigricans* infections were in the past linked to mortalities (Munday et al., 2000, Munday et al., 2003), however, improvements in husbandry and improved location of sites seemed to have eliminated this problem (Nowak, 2004). *Hexostoma thymini* was present in Southern Bluefin Tuna every year; in Croatia this parasite was found only in summer 2005 with 13% prevalence and abundance 0.2. In contrast to *Hexostoma* in Southern Bluefin Tuna, where noticeable gross swelling at the site of attachment is observed (Hayward et al., 2006), no pathological changes were noticed at the site of attachment of the monogenean, possibly due to the small size of the parasite.

### Table 1.

<table>
<thead>
<tr>
<th>Parasites</th>
<th>Southern Bluefin Tuna</th>
<th>Northern Bluefin Tuna (Spain)</th>
<th>Northern Bluefin Tuna (Croatia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciliates</td>
<td><em>Uronema nigricans</em></td>
<td>Not examined</td>
<td>Not found</td>
</tr>
<tr>
<td>Microsporidia</td>
<td>Not found</td>
<td>Not examined</td>
<td>Unidentified</td>
</tr>
<tr>
<td>Myxozoa</td>
<td><em>Kudoa</em></td>
<td>Not examined</td>
<td>Ceratomyxida</td>
</tr>
<tr>
<td>Monogeneans</td>
<td><em>Hexostoma thymini</em> Capsula sp.</td>
<td></td>
<td><em>Hexostoma sp.</em></td>
</tr>
<tr>
<td>Digeneans</td>
<td><em>Cardiola forsteri</em></td>
<td>Unidentified didymozoids</td>
<td><em>Tristomella laevis</em></td>
</tr>
<tr>
<td>Nematoda</td>
<td>Unidentified</td>
<td>Not examined</td>
<td><em>Oncophora melanocephala</em></td>
</tr>
<tr>
<td>Cestoda</td>
<td><em>Callistetrathyynchus gracilis</em> Otobothrium disparum</td>
<td>Not examined</td>
<td><em>Anisakis</em> sp. larvae</td>
</tr>
<tr>
<td>Acanthocephala</td>
<td><em>Rhadinorhynchus pristis</em> Unidentified acanthocephalan</td>
<td>Not examined</td>
<td><em>Hepatothylxon trichiuri</em></td>
</tr>
<tr>
<td>Copepoda</td>
<td><em>Caligus elongatus</em></td>
<td><em>Pseudocycicus appendiculatus</em></td>
<td><em>Blastocystis of presumably</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Euryphorus brachypterus</em></td>
<td><em>Eutetrathyynchus lineatus</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Brachizilla thymini</em></td>
<td></td>
</tr>
</tbody>
</table>

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In Croatia pasteurellosis caused by *Photobacterium damselae* subsp. *piscicida* had a seasonal occurrence, peaking usually in June and deteriorating slowly in 3-5 months (Mladineo et al., 2005). It was diagnosed twice during this study. Fish displayed no external clinical signs of disease except for changed coloration and atypical swimming, and gross pathology was limited to general signs of septicemia. Most fish died in 1-2 days without gross pathology, possibly due to the virulence of the bacterial strain or reduced resistance of the fish. A low percentage of fish developed a chronic form of infection with disseminated granulomas in kidney, also showing no gross pathology. Presence of tuna parasites was evaluated and did not appear to affect the development and the course of the disease (Mladineo et al., 2006). It is suspected that other risk factors included poor diet (including long storage), sudden rise of water temperature, lack of current and forest fires contributed to the outbreak.

No viral diseases have been detected in tuna culture in Croatia, where molecular and histological screening for nodavirus infection was undertaken in the early stages of pasteurellosis. Viral pathogens were not covered by the survey in Spain nor of Southern Bluefin Tuna in Australia.

**Conclusions**

We have significantly increased our knowledge of farmed tuna health. This information is very useful as a baseline for further monitoring and research on health of farmed tuna. A wide range of parasites has been described from farmed tuna. At least some of them were present both in Mediterranean and Australia. No significant health problems were detected in tuna sampled during these surveys. International scientific collaboration has been beneficial to the progress of our research, particularly in the area of taxonomy of parasites.

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**References**


