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Invited Review

Recent advances in our knowledge of Australian anisakid nematodes

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ABSTRACT

Anisakidosis is an emerging infection associated with a wide range of clinical syndromes in humans caused by members of the family Anisakidae. Anisakid nematodes have a cosmopolitan distribution and infect a wide range of invertebrates and vertebrates during their life cycles. Since the first report of these parasites in humans during the early 60s, anisakid nematodes have attracted considerable attention as emerging zoonotic parasites. Along with rapid development of various molecular techniques during last several decades, this has caused a significant change in the taxonomy and systematics of these parasites. However, there are still huge gaps in our knowledge on various aspects of the biology and ecology of anisakid nematodes in Australia. Although the use of advanced morphological and molecular techniques to study anisakids had a late start in Australia, great biodiversity was found and unique species were discovered. Here an updated list of members within the family and the current state of knowledge on Australian anisakids will be provided. Given that the employment of advanced techniques to study these important emerging zoonotic parasites in Australia is recent, further research is needed to understand the ecology and biology of these socio economically important parasites. After a recent human case of anisakidosis in Australia, such understanding is crucial if control and preventive strategies are to be established in this country.

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1. Introduction

Members of the family Anisakidae infect animals of almost all phyla, and are particularly prevalent in fish and aquatic associated animals. In the northern hemisphere, interest in these organisms grew tremendously following the discovery that larval stage of *Anisakis* from the North Sea herring, *Clupea harengus*, are able to infect humans (Van Thiel et al., 1960). Since then there have been many studies carried out that increased awareness, improved diagnostic techniques and broadened our knowledge about various aspects of their biology and pathogenicity. Anisakid nematodes are regarded as economically important parasites that are recognised as emerging seafood borne parasites with unique characteristics. It is known that even one single dead anisakid larva in properly cooked seafood may cause serious disease in humans (Audicana et al., 2002); anisakid larvae do not die immediately after the host's death, migrating instead from internal organs to the flesh of the host, where they are more likely to be transferred to the definitive host(s). Unlike many other common parasitic diseases of humans,

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anisakidosis is not a problem of developing countries only (Gorokhov et al., 1999; Smith, 1999; Lopez-Serrano et al., 2000; Chai et al., 2005; Kapral et al., 2009; Shamsi and Butcher, 2011) (Fig. 1). Hence, it is not surprising that a review of the literature found a sharp increase in the number of publications since the 1960s (Fig. 2). However, to date only 2% of these publications are about Australian anisakids. In the Northern Atlantic and Northern Pacific, the economic importance of the fishing industry has prompted research on the parasites of marine fauna and as a result, many aspects of the biology and ecology of these parasites have been studied, but the parasites of Australian marine animals are poorly known.

The history of studies of anisakids in Australia shows a controversial taxonomy. Australian anisakids are known mostly by the works of Johnston and Mawson in the 1940's but since then there has been no review on importance of those findings and the current status of taxa reported by them. In some recent publications on Australian anisakids wrong taxonomy, old nomenclature and assignment of species to wrong families occur, possibly due to the lack of compact information on changes to the taxonomy and nomenclature of Australian species of anisakids. For example, a common confusion relates to the genus *Hysterothylacium* which was resurrected in 1981 to include those species previously considered as *Thynnascaris* and *Contracaecum* (Deardorff and Overstreet, 1981) and is now classified under family Raphidascarididae (Fagerholm, 1991; Nadler and Hudspeth, 2000) instead of Anisakidae. However, literature review shows there are still 47 publications worldwide, some from Australia, in which *Thynnascaris* has been reported from various hosts or studied, without referring to its significant morphological features in details. Therefore, one cannot draw conclusions about the host, geographical distribution and pathogenic aspects of the specimens reported in these articles. More importantly, *Hysterothylacium* is still reported as an anisakid nematode instead of raphidascarids in some publications. For decision makers in the seafood industry, health sectors and fisheries in several parts of the world, it makes a significant difference in how they deal with anisakids versus raphidascarids. *Hysterothylacium* larvae are very abundant in fish (Shamsi et al., 2013) but they are not as harmful as members of anisakid nematodes for human health. An article that states fish are infected with

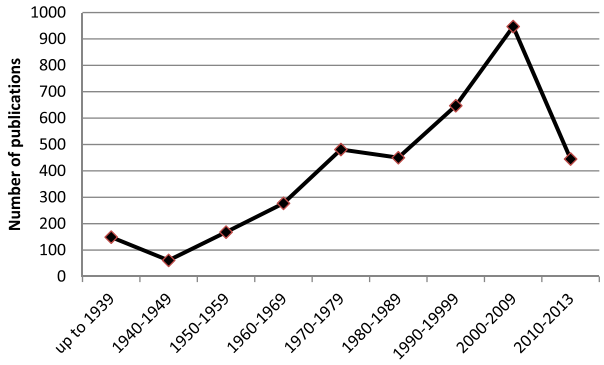

Fig. 2. Number of published articles on anisakid nematodes (key word: Anisakidae) until 2013; based on the search on Web of Science and CABI (Gorokhov et al., 1999; Smith, 1999; Lopez-Serrano et al., 2000; Chai et al., 2005; Kapral et al., 2009; Shamsi and Butcher, 2011).

Hysterothylacium spp. and places them under anisakids can potentially lead to raising a false alert among decision makers who are not necessarily taxonomists at potentially tremendous cost to the Australian fishing industry.

This review presents the history of research on Australian anisakid nematodes, a list of taxa reported in Australia followed by their current taxonomic status, the current state of knowledge on life cycle and health impacts of Australian anisakids, and the questions these findings raise.

2. History of study of anisakid nematodes in Australia

There is a paucity of information on anisakid nematodes in Australia. Australian anisakids are known principally from early works by Johnston and Mawson (Johnston, 1910, 1913, 1937, 1938; Johnston and Mawson, 1939, 1940a,b, 1941a, 1942b,c,d, 1943a,b, 1944, 1945a,b, 1947a, 1949, 1951a, 1952, 1953; Mawson, 1953, 1957, 1969). These authors reported and described 32 species of anisakid nematodes, from a broad range of Australian animals. Although their contribution to our knowledge on anisakid nematodes in Australia is significant, most of these early reports of the

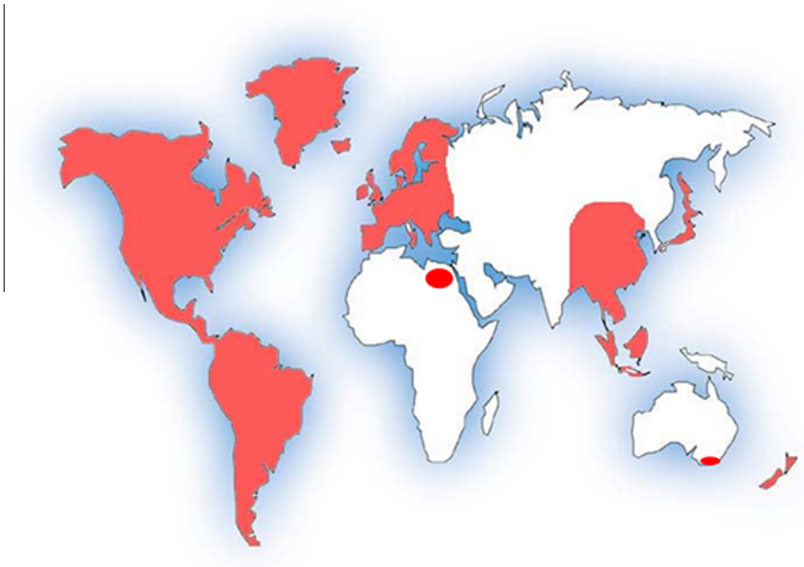

Fig. 1. Countries where human cases of anisakidosis have been reported (Gorokhov et al., 1999; Smith, 1999; Lopez-Serrano et al., 2000; Chai et al., 2005; Kapral et al., 2009; Shamsi and Butcher, 2011).