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Jadwiga GRABDA

Parasitology

STUDIES ON PARASITIC INFESTATION OF BLUE WHITING (*MICROMESISTIUS SP. SP.*) WITH RESPECT TO THE FISH UTILIZATION FOR CONSUMPTION

BADANIA NAD STOPNIEM ZARAŻENIA BŁĘKITKA (*MICROMESISTIUS SP. SP.*) PASOŻYTAMI POD KĄTEM PRZYDATNOŚCI RYB DO KONSUMPCJI

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The invasion extent and parasites' localisation in organs of European blue whiting *Micromesistius poutassou* (Risso) and southern blue whiting *M. australis* Norman were studied. A very strong infestation of European blue whiting muscles by *Anisakis* larvae was found while muscles of southern blue whiting were heavily parasitised by a protozoan, *Kudoa sp.*

A consumability of parasitised fish is discussed.

INTRODUCTION

Owing to a decrease in catches of marine fish, cod and herring in particular, as well as to the unilateral claims to 200-mile exclusive administration zones, the attention has been recently turned to the hitherto unexploited species concentrating in vast amounts around the borders of continental shelf.

Both species of Atlantic blue whiting, namely European blue whiting, *Micromesistius poutassou* (Risso), and southern blue whiting, *M. australis* Norman, can be considered in this context.

European blue whiting occur in the North-East Atlantic off Iceland, Faeroe Islands, British Isles, their distribution range being extended southward to the Iberian Peninsula, western Mediterranean, and Moroccan shelf. The species inhabit the North Sea entering the Skagerrak and Norwegian Sea; the fishes occur also off Spitsbergen to the Barents Sea.

This pelagic species dwelling above the depths of 1000–2000 m past the continental shelf (Svetovidov, 1948) forms major concentrations at depths of ca 400 m.

Southern blue whiting occur off the South America around the Patagonian shelf and the Falkland Islands.

Comprehensive studies are in progress now in order to determine the utilization of these two species for consumption. Some results, summarised by D. Koniecka and W. Wojciechowska in a publication issued by the Sea Fisheries Institute, Gdynia in 1976, indicate both vast resources and possibilities of obtaining various products.

The blue whiting parasitic fauna is relatively poorly known; what is known amounts to some faunistic-zoological aspects while a parasitologic assessment of consumability of these species has been described, to my konwledge, only by Reimer et al. (1971).

MATERIAL AND METHODS

The studies described deal with parasites of muscles and visceral organs, those of the interior of gut being disregarded as irrelevant to our purpose and discarded along with gut during preliminary processing procedures.

Various products obtained from European blue whiting of the spring 1977 catches off North Ireland, namely: whole fishes, beheaded fishes with removed throat, eviscerated and beheaded fishes, spines, and fillets were examined in detail, 50 specimens of each product being taken into account.

20 southern blue whiting individuals (whole fishes) caught on the Argentine shelf in 1974 as well as 11 whole fishes and 50 fillets obtained in January 1977 off the Falklands were examined as well.

The fishes to be examined were brought frozen to the laboratory.

RESULTS

European blue whiting (*Micromesistius poutassou*)

The following parasites were found: cysts of Microsporidia protozoans, cestode *Diphyllobothrium sp.* larvae, and larvae of nematodes: *Thynnascaris adunca* and *Anisakis simplex* (Table 1).

Microsporidia occurring in the form of fine (to 3 mm long) elongated cysts were found in muscles of all sorts of products examined. They are more frequent in ventral than in dorsal muscles, hence a relatively low infestation of spines and fillets.

Table 1

Parasitisation of European blue whiting (*Micromesistius poutassou*)

Product	No of indiv.	Fish size cm/g	*Microsporidia*		*Diphyllobothrium* sp.		*Thynnascaris adunca*		*Anisakis simplex*	
			inv. inc.	inv. int.	inv. inc.	inv. int.	inv. inc.	inv. int.	inv. inc.	inv. int.
Whole fish	50	28–36/ 50–160	10%	10–30 cysts	28%	1–22 larvae	44%	1–40 larvae	98%	7–679 larvae
Beheaded fish with removed throat	50	22–29/ 60–240	18%	1–7 cysts			8%	1–4 larvae	100%	1–173 larvae
Eviscerated beheaded fish	50	21–27/ 60–140	14%	3–23 cysts					90%	1–64 larvae
Spines	50	20–26/ 70–170	4%	single cysts					62%	1–25 larvae
Fillets	50	mean weight 35g	4%	2–7 cysts					88%	1–20 larvae

inv. inc = invasion incidence

inv. int. = invasion intensity

Table 2

Anisakis simplex larvae occurring in various organs of European blue whiting (*Micromesistius poutassou*)

Product	Total invasion		Ventral muscles		Dorsal muscles		Liver		Abdominal cavity (without liver)	
	inv. inc.	mean int.	inv. inc.	mean int.	inv. inc.	mean int.	inv. inc.	mean int.	inv. inc.	mean int.
Whole fish	98%	84.8	74%	15	8%	8.5	90%	55.9	98%	22
Throat-removed fish	100%	26.96	94%	17.7	12%	3.6	–	–	90%	10.8
Eviscerated beheaded fish	90%	14.5	90%	11	24%	2.9	–	–	74%	3.2
Spines	62%	4.5	–	–	–	–	–	–	–	–
Fillets	88%	5.6	–	–	–	–	–	–	–	–

inv. inc. = invasion incidence

int. = intensity

*Diphyllobothrium sp.** plerocercoids in the form of spherical cysts underneath the stomach mucosa were found in 28% of the fish individuals studied.

Thynnascaris aduncа larvae occurred in liver and between viscera in whole fishes and in body cavity of throatless fishes in which the terminal part of intestine is retained.

Anisakis simplex larvae were revealed in all the blue whiting products examined as presented in Tables 1 and 2.

Of the parasites listed above, both *Diphyllobotrium sp.* and *Thynnascaris aduncа* occur only in the body cavity organs discarded along with the parasites in the eviscerating operation. For the fish flesh assessment, however, the *Microsporidia* protozoans are relevant as are *Anisakis simplex* larvae which attack muscles.

The *Microsporidia* appear as fine whitish cysts; they are relatively frequent but not numerous. The examined fishes did not show any pathologic changes; however, a strong invasion which might have a detrimental effect upon the fish flesh quality is not improbable to foresee. The *Microsporidia* discussed are harmless to man and no muscle break-up is evidenced.

On the other hand, the *Anisakis simplex* larvae invasion presents a serious problem, the larvae being harmful for humans exposed to invasion by consuming fresh, raw or semi-raw fish. Fishes containing *Anisakis* larvae are disqualified as a food both for hygienic and aesthetic reasons.

Anisakis larvae occur mainly in fish body cavity. In blue whiting as in many other gadids, most of the larvae settles beneath the liver sheath as flat spirals well-visible even by naked eye. A heavily contaminated liver can be used for oil but not for a direct consumption. Numerous larvae inhabit also fish muscles, mainly ventral ones, where the infestation incidence ranged within 74–94% in fish studied with a maximum invasion intensity of 148 parasites per fish. Dorsal muscles were infested to a much lower degree: an 8–24% invasion incidence and to 23 larvae per fish were found. One should note a relatively high (62%) invasion incidence in blue whiting spines checked (Table 1). This fact can be explained as caused by a rather careless processing whereby the spines obtained are left with parts of ventral muscles and even fragments of liver.

A high degree of invasion in fillets (88%) resulted from summing up the numbers of larvae occurring in dorsal and ventral parts (Table 1).

The parasitisation of European blue whiting muscles increased with the number of *Anisakis* larvae occurring in fish body cavities.

The larvae occurring in muscles are poorly visible against the muscle tissue. They do not form encysted spirals, being loosely scattered and their colour resembling that of muscle fibres which makes them easy to overlook on fish dissection.

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* Plerocercoids of *Diphyllobothrium sp.* described for the first time by Anderson (1977) were found in European blue whiting caught north of the Faeroe Bank. Their morphology and localisation are entirely consistent with my own data.

Table 3

Parasitisation of southern blue whiting (*Micromesistius australis*)

Product	No of indiv. examined	Fish size cm/g	*Kudoa sp.* cysts		*Anisakis simplex*		*Thynnascaris adunca*		*Phocanema decipiens*		Year of study
			inv. inc.	inv. int.	inv. inc.	inv. int.	inv. inc.	inv. int.	inv. inc.	inv. int.	
Whole fish	20	37–55/ 370–1130	65%	single numerous	75%	1–65	50%	1–12	5%	1	1974
Whole fish	11	47–55/ 650–1090	90%	1–62	100%	3–35	36%	1–5	–	–	1977
Fillets	50	mean weight 126g	86%	1–29	–	–	–	–	–	–	1977

inv. inc. = invasion incidence

inv. int. = invasion intensity

Southern blue whiting (*Micromesistius australis*)

Four parasite species were found in southern blue whiting: a protozoan, *Kudoa sp.*, and larvae of three nematode species, *Anisakis simplex*, *Thynnascaris adunca*, and *Phocanema decipiens* (Table 3).

An exceptionally heavy invasion of *Kudoa sp.* protozoans was revealed; they form oval, cream- to milk-white cysts of variable size scattered in ventral and dorsal skeletal muscles. Cysts' length and thickness reached 20 mm and 5 mm, respectively (Fig. 1).

Fig. 1. Southern blute whiting (*Micromesistius australis*) with *Kudoa sp.* cysts in muscles

The largest, milk-white cysts were breaking to form dense centres of pus-like substance around which the muscles underwent deliquescence as well. The substance filling the cysts consisted of 5–6 μm mature spores with 4 polar capsules typical of the genus *Kudoa* (Fig. 2). Smaller, yellowish and harder cysts are filled with parasite's juvenile stages with polar capsules incompletely developed.

65% and 90% of southern blue whiting examined in 1974 and 1977, respectively, were parasitised by *Kudoa sp.*, whereas fillets were infested in 86% (Table 3).

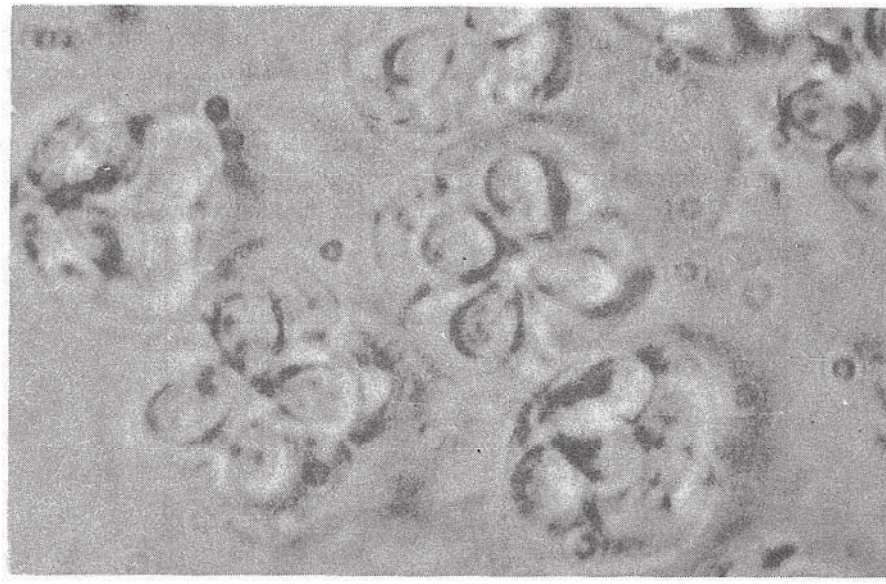

Fig. 2. *Kudoa sp.* spores from southern blue whiting (*Micromesistius australis*). Phot. Jerzy Waluga

Anisakis simplex larvae occurred most frequently in liver, on gonads, intestine, and on peritoneal membrane. On two occasions in a sample examined in 1974, 1–2 larvae were found in ventral muscles. A total parasitisation percentage of that sample was 75% while 100% of fishes were infested in 1977. A maximum number of 64 larvae per fish was found. No *Anisakis* larvae were found in dorsal muscles.

Thynnascaris adunca larvae occurred solely in viscera (on intestine, between pyloric caeca, and on peritoneal membrane).

A *Phocanema decipiens* larva was found on one occasion in dorsal muscles of one individual examined in 1974. This is therefore a sporadic occurrence; however, it should be borne in mind that the nematode in question may infest man. Moreover, a heavy invasion brings about an inflammation of fish muscles and their loosening which is a very unfavourable condition from a technological point of view.

DISCUSSION

The parasitologic analysis performed on the two blue whiting species showed rather considerable differences between their parasitofaunas, both in terms of numbers and species composition of parasites (Tables 1 and 3).

Two parasitic species are particularly relevant to fish processing: *Anisakis simplex* larvae and *Kudoa sp.* The former occur in varying degree of intensity in both the blue whiting species while the latter were found in southern blue whiting only.

The *Anisakis* invasion incidence reached 100% in either blue whiting species, European blue whiting showing a much higher invasion intensity (Table 1 and 3). Muscles in all the products examined had been attacked to a very high degree with up to 148 larvae per fish, whereas southern blue whiting dorsal muscles were completely parasite-free and single larvae were sporadically found in ventral muscles.

I failed to find any data on the *Anisakis* larvae occurrence in southern blue whiting. Szidat (1961) as referred to by Reimer et al. (1971), did not include this species into the southern blue whiting parasitic fauna; he was, however, dealing with only 3 fish individuals, therefore his results could not reflect a complete parasitisation picture of this fish species. Thus only my own material remains as a reference. On the other hand, *Anisakis* was being found several times, by various authors, in European blue whiting. Poljanskij (1955), when studying parasites of the Barents Sea fishes, examined also 5 individuals of blue whiting containing single larvae on liver and in the body cavity. Berland (1961) examined 15 Norwegian Sea blue whiting individuals (12 from off Hordaland and 3 from off Tromsö), 10 of which contained the *Anisakis*, larvae. No number of larvae found was given though.

Reimer et al, (1971) worked on the amplest supply of Atlantic blue whiting. One sample consisting of 100 fish individuals was caught NW of Iceland whereas the other (80 individuals) was obtained on a fishing ground to the West of Ireland. The authors found high invasion incidences of 70% and 67.8% in fish off Iceland and Ireland, respectively. The authors discussed were finding the larvae occurring as encysted flat spirals on liver, gonads, pyloric caeca, and on body walls. The invasion intensity is given for *Anisakis* and *Thynnascaris aduncа* combined, thus there is a lack of exact numerical data on the invasion.

None of the authors mentioned has found *Anisakis* in fish muscles, which has prompted the German workers to conclude that flesh of European blue whiting studied can be commercially processed ("Die Muskulatur von *M. poutassou* war frei von Parasitenbefall und ist vom parasitologischen Standpukt gut für eine wirtschaftliche Nutzung geeignet").

Our own materials give no justification to such a conclusion. It can be that blue whiting is parasitised to differing degress both in various fishing grounds and in different seasons. Poorly discernible larvae are also likely to be overlooked on examination.

As seen from the evidence presented above, the preliminary treatments such as evisceration, removal of throat, filleting do not remove all larvae from blue whiting; their considerable number remaining creates a possible hazard for human health.

Of the products examined, spines are the least parasitised. The hazard would still be smaller, should the spines be cut off more carefully so that ventral muscles are completely removed. The same applies to the removal of remains of viscera, liver and intestine, which can house fair numbers of larvae. A few larvae remaining in dorsal muscles would not then jeopardise human health.

This method of spines production is commercially implemented in the USSR with

respect to Alaska pollack (*Theragra chalcogramma*), a gadid species exposed to a very heavy parasitisation. The method was described by Mamaev and Baeva (1963).

From the parasitologic standpoint, blue whiting spines could be a good starting material for fish mince and other products. The mince obtained from whole blue whiting would contain large numbers of parasites which is incompatible with sanitary requirements. In blue whiting mince examined in 1974, not only very numerous fragments but also intact *Anisakis* larvae were revealed. Assuming 10 fragments per 1 larva, approximately 4.7 larvae, 1 intact one included, were found in every 100 g of meat. The value of such mince is doubtful in spite of the fact, revealed by the preliminary studies on the *Anisakis larvae* toxicity tests on white mice, that nematode toxins decompose at $-25^{\circ}C$ and $+100^{\circ}C$ (Grabda and Felińska, 1975).

Another parasite relevant to the blue whiting value as food is *Kudoa sp.*, found only in southern blue whiting (Table 3). This parasite is not invasive for man, but serious changes in fish muscles are induced due to strong proteolytic enzymes produced which dissolve the muscles in the centres of invasion.

Patashnik and Groninger (1964), when studying invaded halibut, showed the enzymatic activity (of the magnitude order of 500–700 μg of tyrosine released from 1 g of material over one hour) to occur only within the milk zone, the clean parts of muscles showing a negligible if not non-existent proteolytic activity. Moreover, the authors discussed found the chemical composition of invaded muscles (fluid, protein, fat, dry matter, natrium and potassium contents) to be comparable with the standards; they concluded that the parasitised halibut, although being of a lower quality, can nevertheless be used for consumption.

Southern blue whiting examined during the present studies showed a very heavy invasion (up to 90%); even assuming the *Kudoa* harmlessness and unaltered chemical composition of invaded muscles, the blue whiting consumability seems doubtful due to a detestable appearance of the muscles.

The blue whiting parasitisation is so strong that it is virtually impossible to sort out the invaded fillets. The selection will only reject those fillets containing large milky cysts. Moreover, *Kudoa sp.* occur both in ventral and dorsal muscles along the whole fillet length so that mechanical cutting cannot be applied as opposed to European blue whiting and Alaska pollack.

Nodzyński (1974) points to the presence of numerous nematodes on liver surface as well as to heavily parasitised fillets. This author identifies no parasites but he was presumably dealing with *Anisakis* larvae and *Kudoa* cysts in liver and muscles, respectively. 30–64% of his fillets were parasitised. In this author's opinion, this heavy parasitisation excludes blue whiting caught off the Falklands from human consumption, the fish resources should be utilised for fish meal production instead.

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BADANIA NAD STOPNIEM ZARAŻENIA BŁĘKITKA (*MICROMESISTIUS SP. SP.*) PASOŻYTAMI POD KĄTEM PRZYDATNOŚCI RYB DO KONSUMPCJI

Streszczenie

Zbadano różne asortymenty błękitka europejskiego – *Micromesistius poutassou* (Risso) oraz błękitka południowego – *M. australis* Norman.

W błękitku europejskim znaleziono cysty pierwotniaków *Microsporidia*, larwy tasiemca *Diphyllobothrium sp.* i larwy nicieni *Anisakis simplex* i *Thynnascaris adunca* (Tab. 1).

W błękitku południowym występowały cysty pierwotniaków *Kudoa sp.* i larwy nicieni *Anisakis simplex, Thynnascaris adunca* i *Phocanema decipiens* (Tab. 3).

Z punktu widzenia przydatności błękitków do spożycia najważniejszymi gatunkami pasożytów są larwy *Anisakis* i *Kudoa sp.* Pozostałe gatunki pasożytów występują w niewielkiej liczbie lub wyłącznie w trzewiach i wraz z trzewiami są likwidowane przy patroszeniu ryb.

Anisakis stwierdzono w obu gatunkach błękitka przy ekstensywności inwazji około 100%. Natomiast intensywność inwazji była znacznie wyższa w błękitku europejskim. Znajdowano tu do

679 larw w jednej rybie, podczas gdy maksymalne zarażenie błękitka południowego wynosiło 64 larwy. Ponadto bardzo silnie były zaatakowane mięśnie szkieletowe błękitka europejskiego zwłaszcza w partii brzusznej (Tab. 2). Błękitek południowy miał mięśnie wolne od larw *Anisakis*. Jedynie w dwu przypadkach znaleziono po 1–2 larw w rybie w mięśniach brzusznych.

Przedyskutowano możliwość wykorzystania do spożycia mięśni błękitka europejskiego w postaci grzbietów, jaki zawierających stosunkowo małą liczbę larw, przy przestrzeganiu warunków mrożenia, jako podstawowej metody zabijającej wszystkie larwy w rybie i zabezpieczającej człowieka przed zarażeniem.

Cysty *Kudoa sp.* stwierdzono tylko w mięśniach błękitka południowego, rozsiane na całej przestrzeni filetu, w różnych stadiach rozwojowych. Dojrzałe cysty mlecznej barwy rozlewają się w postaci gęstej półpłynnej masy, tworząc ogniska, wokół których mięśnie ryby ulegają rozpuszczeniu.

Biorąc pod uwagę wygląd mięśni zarażonych przez *Kudoa* budzący odrazę (Rys. 1), a także zmianę struktury mięśni w miejscach zarażonych, wykorzystanie błękitka do spożycia jest dyskusyjne, mimo że człowiek tym pasożytem nie zaraża się, a skład chemiczny mięśni zarażonych nie odbiega od normy (Patashnik i Groninger, 1964).

Я. Грабда

ИССЛЕДОВАНИЕ СТЕПЕНИ ЗАРАЖЕНИЯ ПУТАССУ (MICROMESISTIUS SP. SP.) ПАРАЗИТАМИ С ТОЧКИ ЗРЕНИЯ ПИЩЕВОЙ ПРИГОДНОСТИ РЫБЫ

Р е з ю м е

Были исследованы ассортименты европейского путассу - Micromesistius poutassou (Risso) - и южного путассу - M. australis Norman.

У европейского путассу были обнаружены цисты простейших - Microsporidia, личинки цестод - Diphyllobothrium sp. и личинки нематод Anisakis simplex и Thynnascaris adunca (табл. 1).

У южного путассу встречались цисты простейших - Kudoa sp. и личинки нематод Anisakis simplex, Thynnascaris adunca и Phocanema decipiens (табл. 3).

С точки зрения пищевой пригодности путассу наиболее опасными видами являются личинки Anisakis и Kudoa sp. Остальные виды паразитов встречаются только в небольшом количестве или же только во внутренностях, вместе с которыми они удаляются при потрошении рыбы.

Anisakis были обнаружены у обоих видов путассу при экстенсивности инвазии около 100%. Интенсивность же инвазии была значительно более высокой у европейского путассу, у которого находили до 679 личинок в одной только рыбе. Максимальное заражение южного путассу составляло 64 личинки. Сильно заражёнными были скелетные мышцы европейского путассу, особенно в брюшной части (табл. 2). У южного путассу мышцы не были заражены Anisakis. Только в двух случаях было обнаружено по 1-2 личинки в брюшных мышцах рыбы.

Рассмотрена возможность пищевого использования мышц европейского путассу в виде „спинки", содержащей сравнительно небольшое количество личинок.

При этом предполагается соблюдение соответствующих условий замораживания как основного метода обработки, при котором уничтожаются все личинки в рыбе и потребителю не угрожает опасность заражения.

Цисты Kudoa sp. обнаружены только в мышцах южного путассу; они рассеяны по всей поверхности филейной части в разных стадиях развития. Созревшие цисты имеют молочный цвет и разливаются в виде густой полужидкой массы, создавая очаги, вокруг которых мышцы рыбы подвергаются распаду.

Учитывая, что мышцы, заражённые Kudoa sp., имеют весьма непривлекательный вид и что структура их в заражённых местах нарушена, возможность использования путассу в пищу является довольно сомнительной несмотря на то, что человек не подвержен заражению этим паразитом, а химический состав заражённых мышц не отклоняется от нормы (Patashnik и Groninger, 1964).

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