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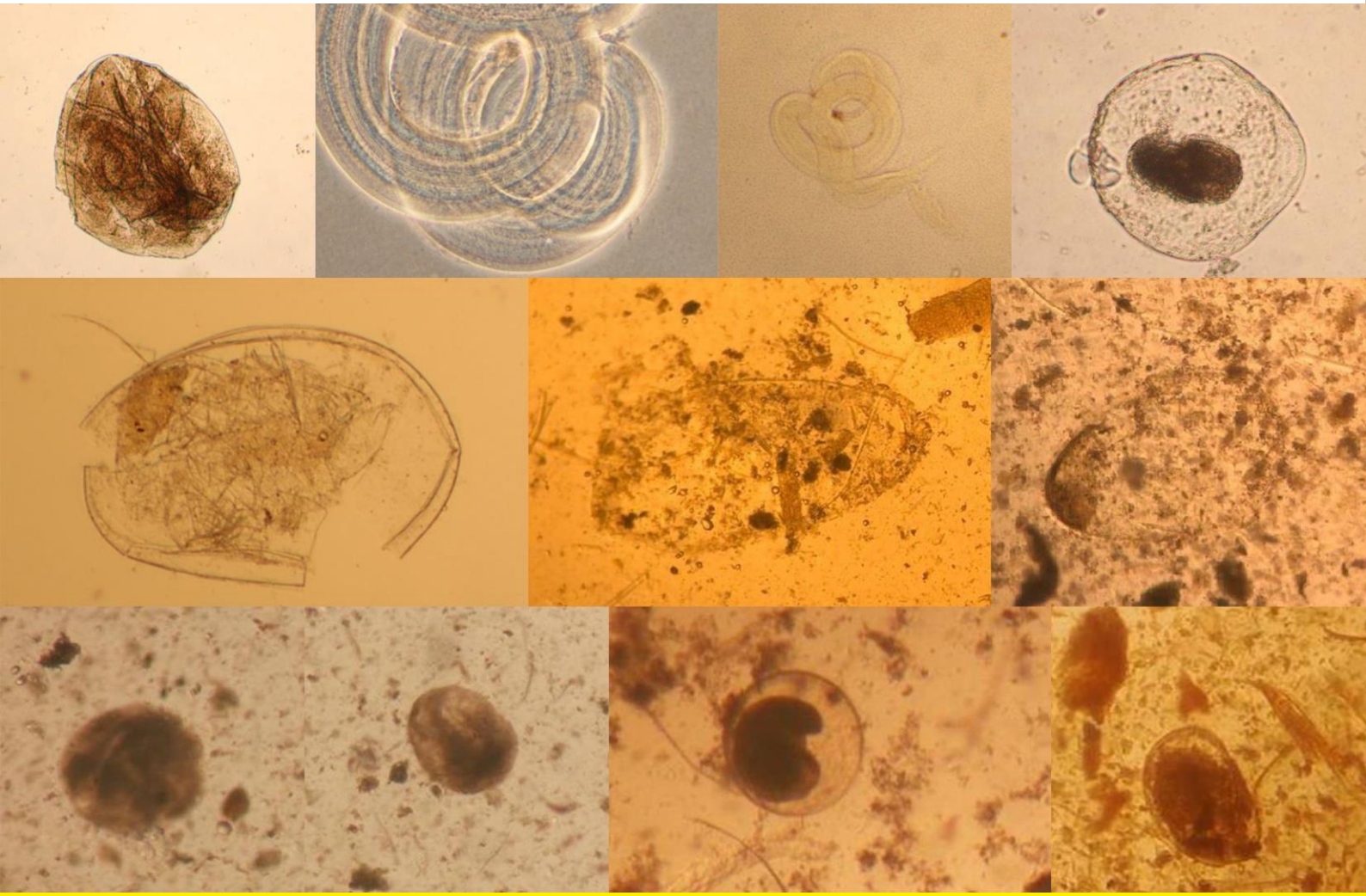

MYSAP
Myanmar Sustainable Aquaculture Programme
မြန်မာရေသတ္တဝါမွေးမြူရေးကဏ္ဍရေရှည် ခိုင်မြဲတိုးတက်ရေးစီမံကိန်း

Screening of fish and shrimp-based pastes for the presence of parasites:

An analysis of pastes from Myanmar

WorldFish

FishVet Group

Implemented by:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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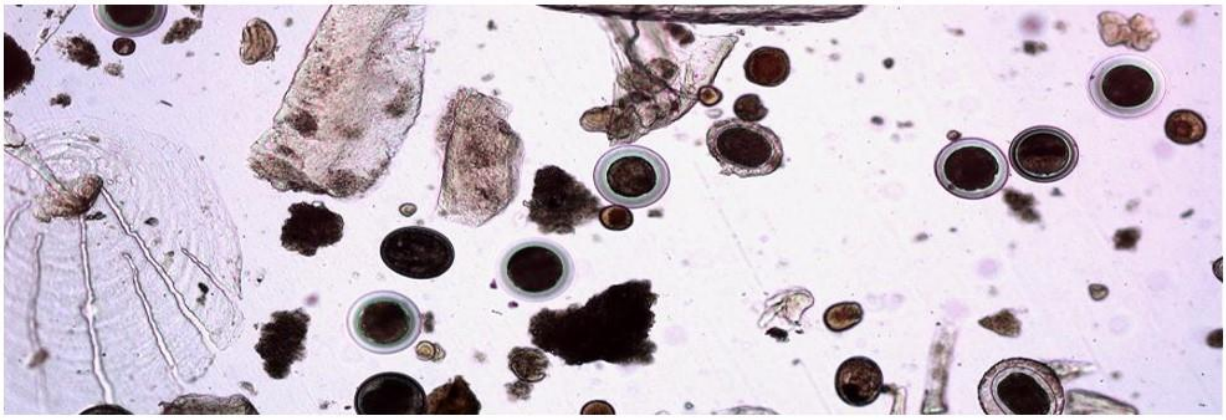

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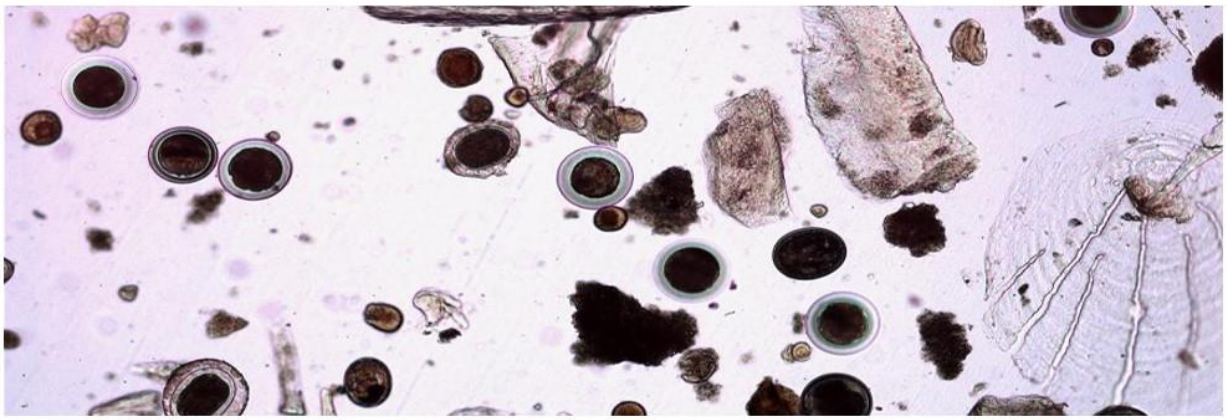

Image shows numerous digenean metacercariae that have been isolated from freshwater fish tissues from a study in Korea. The material is not from the current study. Image courtesy of G.H. Yoon.

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Abstract

A literature search of the aquatic species used to make fish and pastes revealed only one parasite, the zoonotic nematode *Gnathostoma spinigerum*, had been previously recorded in Myanmar. This is a species that infects several freshwater fish species; man can be infected when fish infected by this nematode are eaten raw or the fish is improperly cooked. A parasite screening study of 41 fish and shrimp paste samples sourced from Myanmar found potential parasite species in ten of the pastes.

This study highlights that much of fish parasite fauna of Myanmar is unknown and requires establishing. The study also calls particular attention to the importance of cooking fish and shrimp pastes before consumption to ensure the parasite life-cycle stages are killed, and also the need for further study to identify to species level parasites in aquatic products that are of concern for human health.

Key findings from the study

- A literature search of the aquatic species used to make the pastes, revealed that only one parasite has been previously recorded from Myanmar – the zoonotic nematode *Gnathostoma spinigerum*.
- The parasite fauna of eleven species of fish, identified by the collector of the pastes, is summarised in a 16-page table (Table 1) accompanying this report.
- The parasite fauna lists >180 parasite species from four parasite classes that have species that can infect man, i.e. from the Acanthocephala, Cestoda, Nematoda, and, Trematoda.
- Of the parasite species listed, 25 species are known from the literature to have infected humans.
- Nothing has been previously recorded from *Setipinna wheeleri* or from its associated synonyms (i.e. *Setipinna telara*; *Engraulis telara*).
- Only one parasite is recorded from the Ramcarat grenadier anchovy (*Coilia ramcarati*).
- Only a single unidentified nematode and an unidentified cestode are known from *Trichogaster pectoralis* and its associated synonym (i.e. *Trichogaster pectoralis*).
- The parasite fauna of *Mystus cavasius* appears to be unknown. Cross checks included all its associated synonyms (i.e. *Macrones nigriceps*; *Pimelodus cavasius*; *Aoria cavasius*; *Bagrus cavasius*; *Macrones cavasius*; *Hypselobagrus nigriceps*; *Mystus mukherjii*).

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- The shrimp species used in the pastes were not identifiable by the collector nor are identifiable from the pastes by microscope-based methods.

- The "barb" species used in several of the pastes were not identifiable by the collector. At least 18 "barb" species are recorded from Myanmar. The parasite fauna of eleven of these are unknown.

- Ten of the pastes contained potential parasite species (1 paste containing *A. testudineus*; 1 containing *A. testudineus* + *N. notopterus*; 2 containing "barb"; 1 containing *C. striata*; 1 paste containing *M. cavasius*; 2 containing *Trichopodus pectoralis*; 1 containing *Labeo rohita*; and, 1 containing different fish species). Almost all containing egg-like structures.

- The finding of previously unreported parasites in these fish samples collected from Myanmar highlights the need to better study its parasite and fish fauna, notably aquatic species that are destined for human consumption.

- Of these, the paste containing *M. cavasius* is perhaps the most interesting of those studied here, as a number of egg-like structures were recovered which require identification to determine if they are parasitic in nature and given that nothing is known of the parasite fauna of this host, this warrants further research.

- The finding of a nematode in a paste containing a mix of *A. testudineus* + *N. notopterus.*

- The tentative finding of *Psorospermium* but the confirmed finding of insect parts in at least five samples, one sample with many insect pupae, may allude to a review of the sanitary preparation and storage of samples, though the insect parts may have equally resulted from the intestinal contents and a part of the fish's diet.

- The study found that current consumption practices described boiling, frying and simmering the fish paste and shrimp pastes, though some fermented fish products were reported to be consumed raw.

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Background

The Myanmar Sustainable Aquaculture Program (MYSAP) which is funded by the European Union (EU) and the German Federal Ministry of Economic Development and Cooperation (BMZ) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has the following objective:

Support the sustainable intensification of the aquaculture sector, thereby realizing its potential for food security, nutrition and sustainable livelihoods.

MYSAP is promoting small-scale aquaculture and improved human nutrition in five townships in the Shan State and the Sagaing and Mandalay Regions of Myanmar in its component MYSAP Inland. WorldFish Myanmar is implementing MYSAP Inland under a GIZ grant agreement. The MYSAP Inland townships are:

i) Kale (ကလေး - MMR005027) Township, Sagaing Region
ii) Shwebo (ရွှေဘို - MMR005004) Township, Sagaing Region
iii) Kengtung (ကျိုင်းတုံ - MMR016001) Township, Eastern Shan State
iv) Pinlaung (ပင်လောင်း - MMR014009) Township, Southern Shan State
v) Amarapura (အမရပူရ - MMR010006) Township, Mandalay Region

Following an advertised open tender, Fish Vet Group Asia Limited, a commercial company was contracted under a service agreement with WorldFish Myanmar to conduct *Screening of fish and shrimp-based pastes for the presence of parasites: An analysis of pastes from Myanmar*.

The findings of this MYSAP Inland screening of fish and shrimp pastes for the presence of parasites will be used by the Government of Myanmar, the EU and BMZ, MYSAP and collaborating implementing partners to design and implement activities to improve the food safety of fish and shrimp paste products.

For further information on MYSAP please contact the Head of Programme Mr Peter Buri (peter.buri@giz.de) and for further information on MYSAP Inland please contact: inlandmysap@cgiar.org.

For further information on the findings of this parasite screening study, please contact Dr Andy Shinn, Fish Vet Group Asia Limited at andy.shinn@fishvetgroup.com.

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The rationale and background to this study

The World Health Organization (WHO) categorises parasites among the six most harmful infective diseases of man with parasitic infections outranking cancer as the number one killer in the world. Parasites can be contracted by a variety of routes including the consumption of contaminated, under-cooked fish and meats, from walking barefoot on infected soil, by being bitten by flies or mosquitoes, by eating unclean raw fruits and vegetables or by drinking and working in infected water. A brief overview of this, with a list of annual parasite-associated mortalities is discussed by Hotez & Herricks (2015). For foodborne parasites, Torgenson *et al.* (2015) estimated that are 48.4 million cases (43.4-79.0 million) and 59,724 (48,017-83,616) deaths each year resulting in 8.78 million Disability Adjusted Life Years (DALYs). Within these figures, infections caused by intestinal flukes are prominent. Fish-borne zoonotic parasites (*i.e.* parasites that do not as part of their normal life-cycle infect man but have the ability to infect man as an atypical host) such as the liver and intestinal flukes are recognised as an important group of emerging and re-emerging parasites. Among these, two of particular importance are *Opisthorchis sinensis* (formerly known as *Clonorchis sinensis*) or the Chinese liver fluke (20 million suspected cases) and *Opisthorchis viverrini* or the Southeast Asian liver fluke (9 million suspected cases), which infect a wide range of freshwater fish hosts. There are at least 50 other species of intestinal flukes that also have zoonotic potential and represent a risk to humans. Given man's predilection to the consumption of processed aquatic products as an accompaniment or addition to the main meal, this study will take a look at a small number of shrimp and fish pastes prepared in and collected from Myanmar. The general consumption of these processed products may take various forms from forms that are unprocessed fermentation and consumed raw as an additive to dishes, through products that are either brined, salted, chilled or lightly cooked through to those that undergo significant processing, cooked, and maturation in their production.

In this short diagnostic report, we take a quick look at the published parasite fauna of the fish species used in the fish pastes collected from Myanmar, their documented ability to infect man, their known occurrence in Myanmar territory from the literature, and then the analysis of the samples that have been received, providing comments, where possible, on the species found.

Fish paste sampling method: the markets sampled

For this study a range of fish and shrimp pastes were collected from a variety of markets in Myanmar; the market sampling component of this was conducted by WorldFish researcher, Ms Quennie Rizaldo. A total of 44 samples were collected; of which 20 samples were fish paste, 10 were shrimp paste, and 3 samples were pickled / fermented fish. The fish and shrimp paste samples were collected from two wholesale markets in Yangon - namely Thiri Mingalar Market and Bayint Naung Market, while the fermented / pickled fish samples were collected from retail outlets in Mezali, Ayeyarwady, Delta. The sample collection activity was conducted over a period of 4 days.

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Prior to sample collection, a protocol following a standard procedure was developed to ensure that samples were of a good quality, were free of evident cross-contamination and that all samples were clearly labelled. As part of the collection process, a questionnaire that included questions regarding the place of origin, the process of paste production, the product's proposed shelf-life, and the ingredients specifically, the species of fish species used in the formulation of the paste. During the collection period, particular shops were selected depending on the range of products that were on display. The shop owner / keeper was informed on the purpose of the sample collection and their consent was acquired prior to the collection of relevant samples.

For each sample, 50 grams of the product was placed in a sterile container with a tight-fitting lid, labelled, and then placed inside individual, resealable zip-lock bags. After collection, the shop owner / keeper was interviewed to ensure all the supporting data was gathered. The samples were then transferred to and stored in a domestic refrigerator at 4˚C. The samples of fermented / pickled fish were taken from sites approximately at a hour travelling distance from the main place of work. These samples were immediately wrapped in banana leaves after their purchase, placed in individual zip-lock bags and then transferred to labelled pots, bags and stored in the fridge following arrival back to the main office. The samples were stored for a maximum of 6 days in the fridge and then were sent to the WorldFish office in Mandalay, a journey taking approximately 6-hours by road. The samples were then held for a further 10-days under refrigerated conditions and then the 41 samples were hand carried onto Bangkok, Thailand to the FVG Asia laboratory for analysis.

The known parasite fauna of the fish species passed for analysis

A total of eleven species of fish were identified as key components in the pastes that were submitted for analysis. As supporting background and information to this study, the known parasite fauna of these species is provided in **Table 1** (16 pages long) at the end of this report. In assembling this table though, it is important to note that the species listed are all metazoans and from parasite classes that contain species that can infect man (i.e. only parasite species from the Acanthocephala, Cestoda, Nematoda and Trematoda are considered). The parasite list does not include apicomplexans and protozoans nor species from the classes Monogenea, Crustacea and Turbellaria; the latter three of which do not infect man. For the sake of completeness, species from the Hirudinea, the Oomyceta and Fungi are also excluded from this assessment.

In addition to the named species of fish, the accompanying Excel sheet also refers to "krill" and to "barbs". Neither of these were identifiable from the pastes and an attempt in identifying these here would go beyond the bounds of this particular analysis. It is interesting to note though at least 18 "barb" species, identified here only by their name in English, are recorded from Myanmar – these are briefly listed in **Table 2**. What is also interesting is that the parasite fauna of eleven of these species are unknown.

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Table 2. Species of "barb" identified by the term "barb" in their English name and recorded from Myanmar.

Species	In Myanmar	Common name	Local name	PFK*
Barbodes binotatus	native	Spotted barb	Nga-nyanma	No
Barbonymus gonionotus	introduced	Silver barb	Nga khone ma kyee	No
Cyclocheilichthys apogon	native	Beardless barb		Yes
Esomus danrica	native	Flying barb		Yes
Hampala macrolepidota	native	Hampala barb		Yes
Laubuka laubuca	native	Indian glass barb		No
Megarasbora elanga	native	Bengala barb		No
Osteochilus vittatus	native	Bonylip barb		Yes
Pethia phutunio	native	Spottedsail barb		No
Puntius chola	native	Swamp barb	Nga-nyanma	Yes
Puntius puntio	native	Puntio barb		No
Puntius sophore	native	Pool barb	Nga-buzi	Yes
Puntius terio	native	Onespot barb		No
Raiamas bola	native	Trout barb		No
Sawbwa resplendens	endemic	Sawbwa barb		No
Systomus rubripinnis	native	Javaen barb		No
Systomus sarana	native	Olive barb		No
Tor tor	native	Tor barb	Nga-dauk	Yes

*Parasite fauna known

Sampling of pastes for parasites

A total of 41 pastes were collected by Ms Quennie Rizaldo a researcher from WorldFish Myanmar and then hand delivered to Fish Vet Group Asia Ltd. An Excel sheet providing the full details of the paste contents, preparation and uses was supplied by Ms Rizaldo and an edited version of this accompanies this diagnostic report.

Preparation of pastes for digestion

The pastes consisted of two forms – smooth krill pastes and pastes containing fish. The krill pastes were processed to a high degree, *i.e.* had been ground to a fine paste. The fish "pastes" consisted of fish in variable states of processing from rough, ground pastes through to samples containing whole, salted fish (see **Figure 1**). A sample of 5 g of tissue was processed from each sample, for samples containing whole fish though a targeted sample was taken with the intestinal contents and the musculature overlying the intestines (i.e. the belly flaps) being used. As many parasites use the intestine as a colonisation route with subsequent migrations and encystments in the immediate musculature surrounding the abdominal cavity, for this scoping study, it felt appropriate to target these tissues.

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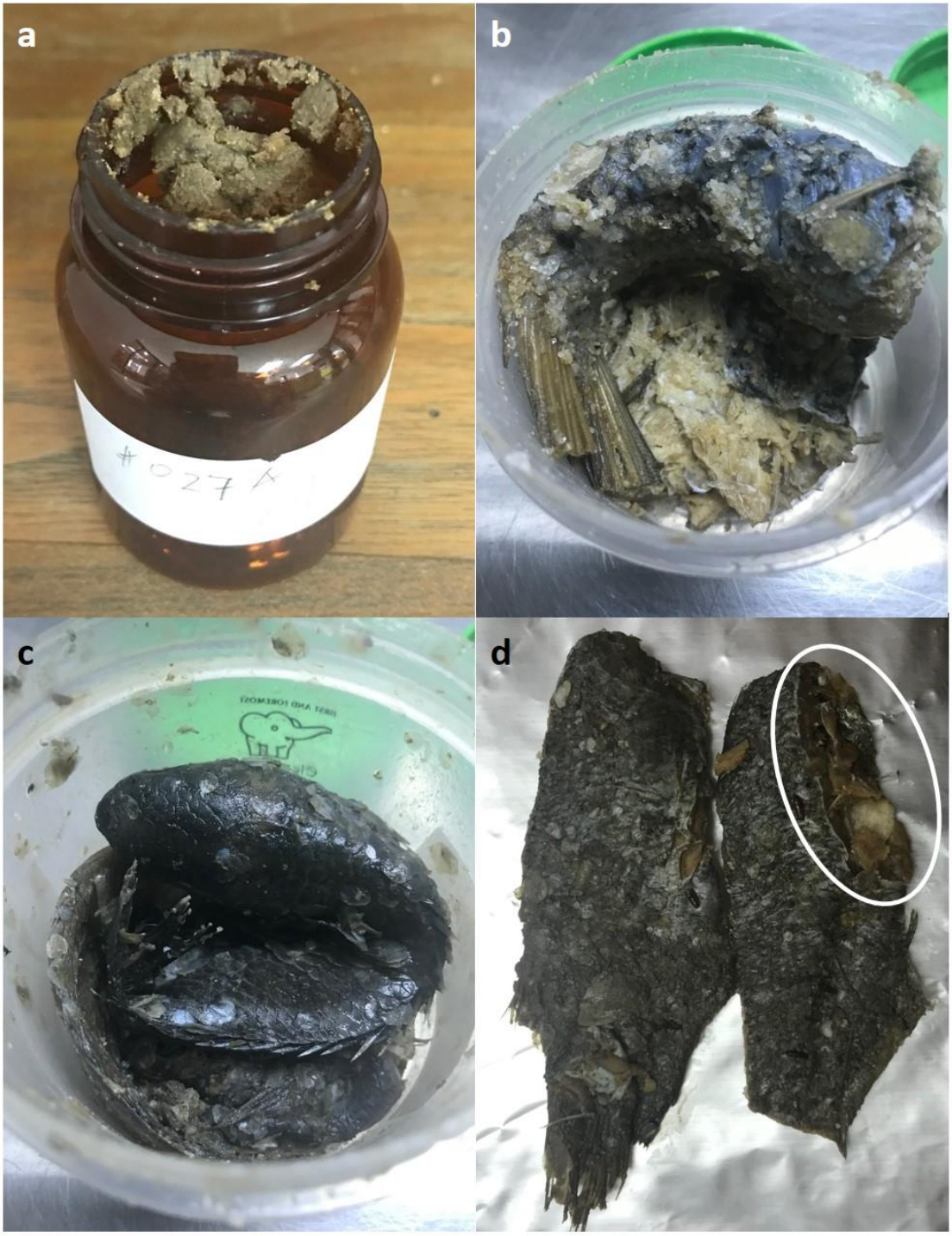

Figure 1. Paste samples. **a** = Sample 27A - a paste made of krill (species not known); **b** = Sample 21 - a "paste" containing whole rohu (*Labeo rohita*); **c** = Sample 15 – a "paste" containing climbing perch (*Anabas testudineus*) and bronze featherback (*Notopterus notopterus*); and, d = Processing of fish samples for proteolytic digestion. Each sample consists of 5 g of "paste". For samples containing whole fish a targeted sample of intestinal and the overlying musculature, i.e. the "belly flaps" (circled) were taken.

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Proteolytic digestion and screening of samples

Following the method of Llarena-Reino *et al.* (2013), 5 g samples of each paste were digested using pepsin (P7000 pepsin from porcine gastric mucosa >250 U/mg; Sigma-Aldrich Co., USA) at 37˚C for 4 hours in a Memmert UN 110 temperature controlled incubator without continuous stirring but with frequent agitation throughout the digestion step. A 1:20 w/v pepsin ratio was used with 1 g of paste per 20 ml of a 0.5% pepsin solution in 0.063M HCl pH 1.5 in 0.85% NaCl as a substitute for physiological saline. After digestion (i.e. the tissue had been completely digested), sub-samples of the digestate were diluted through the addition of 0.85% NaCl / saline and then screened in 85 mm diameter plastic Petri dishes on an Olympus SZ51 dissecting microscope fitted with WHSZ10X-H/22 eyepieces at magnifications of 0.80 through to ×4. Any structures requiring detailed identification were first photographed using either directly transmitted or additional incident lighting and a mobile phone (in this study either a Huawei P10 or an iPhone 8) directly through the microscope eyepiece. The structures were then removed using a 1 ml Pasteur pipette and transferred into 1.5 ml Eppendorfs filled with 95% ethanol. Structures thereafter, were mounted on glass slides in a drop of 0.85% NaCl, coverslipped where necessary, and examined on an Olympus CH2 tri-ocular compound microscope at magnifications of ×4-20 and photographed using a Canon EOS 7D (W) SLR camera using a phototube and an interfacing 3.3× lens.

Molecular-based identifications

It had been proposed in the original quote that a molecular-based investigation of certain samples might follow, where appropriate to do so. As most of the pastes had been prepared for some months prior to their collection (and in some cases up to one year), and most of the parasite samples that were recovered were in a degenerated state (see image plates), it was not appropriate to conduct downstream molecular tests as the quality of the DNA that would have been recovered would, have in all high probability, also been in a highly degraded state and would not generate useful data.

Study findings

A total of 41 pastes were received. From the Excel sheet accompanying the samples (returned as a separate, edited addendum to this report), a total of 44 samples were listed but samples 11-13 were not among those submitted in the shipment for analysis. At least one 5 g sample was processed from each paste, with a second sample being taken from others where either the first sample did not reveal structures for identification or where it was worthy to try a second sample to find parasites. **Table 3** (included at the end of this report), provides a summary of all the structures that were found and that were identified within this study. This is supported by a series of image plates (**plates 1-5**), that provide pictorial evidence of what was encountered and identified.

Degenerated egg-like structures / cysts were found in a number of samples (*i.e.* 10, 16A, 16B, 17B, 20, 24A, 30A, 30B, 33). Unfortunately, their condition was such that these are only tentatively proposed as being parasitic

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in nature and so it was not possible to classify these to class (*e.g.* Digenea, Nematoda *etc*). At least two types of structures were seen – a circular egg-like structure generally devoid of content, and, an elongated structure with an apical process. The most interesting of these are the elongated forms seen within Sample 20 (a paste made from *Mystus cavasius*) - see **Plate two, a and b**. These do not appear to be plant-based, have a shell and an apical structure. Nothing is known of the parasite species of this fish, the Gangetic mystus, and so if the identity of the egg is confirmed to be of parasite origin, it would represent one of the first reports of a parasite from this species. This is, therefore, academic interest to collect fresh species of this host and determine its parasite fauna. Also, of interest is the finding of a nematode in Sample 15 - a paste made from climbing perch (*A. testudineus*) and bronze featherback (*N. notopterus*). At least two nematode species are known from climbing perch (see **Table 1**), one of which is zoonotic. Unfortunately, only the hind part of the worm was recovered making identification of this specimen very difficult. It is not, however, believed to be *Gnathostoma spinigerum*, a species which is of some concern, is responsible for creeping disease, is commonly encountered and has been previously recorded as the only parasite from a fish from Myanmar. The worm was in a good condition, despite it being in half, and according to the collector's note, a sample that was over 3 months in age at the time of collection. By explanation, human gnathostomiasis or creeping disease is an infection by the migrating third-stage larvae of any of five species of *Gnathostoma* nematodes. Gnathostomiasis is transmitted by the ingestion of raw or improperly cooked definitive hosts such as freshwater fish and shrimp, poultry, or frogs. In Thailand and Vietnam, as an example, the most important cause of infection appears to be through the consumption of undercooked Asian swamp eels (*Monopterus albus*) which transmit the parasite. The tentative finding of *Psorospermium*, a species that has been found in freshwater species, *e.g.* crayfish, but also in cockroaches and, the confirmed finding of insect parts in at least five samples, one sample with many insect pupae, may allude to a review of the sanitary preparation and storage of samples, though the insect parts may have equally resulted from the intestinal contents and a part of the fish's diet but given the condition of the various stages encountered it is most likely their occurrence is post-paste preparation, possibly during their storage.

The study had anticipated finding a number of digenean metacercarial stages, an intermediate parasite stage that encysts within, typically, a fish host waiting until it is consumed by the parasite's final host (normally a bird, mammal or another fish species), in which it then develops into the final stage of the parasite and produces eggs. An image of some such stages is shown on the title page. The proteolytic digestion approach is a common method for the release of such stages from enclosing tissue. Some of the egg-like structures may actually represent such stages but given their degenerated state this is difficult to say what they are with any certainty. One arguable drawback of the study is the size of the fish sample that was processed, and this results only from a time vs cost basis. As parasites can infect and encyst in multiple sites on the fish, this study's targeted approach of investigating the intestine and belly flap musculature only may mean that a number of potential parasites have been missed (*e.g.* in the main musculature, in the muscles surrounding the jaws, fins, eyes, brain *etc*). In addition, the salting methods used in the preparation of the pastes, over the time period of their storage and

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before their analysis may also have effected changes to the parasite tissues making them unrecognisable in the proteolytic digestion filtrates, though it is felt that if the metacercarial stages were present these would have been detected by the methods used here.

Conclusions and recommendations

While the study has identified a number of potential parasite stages from the aquatic pastes, the accompanying document supplied by the WorldFish researcher suggests that the local cultural practices concerning the consumption of these pastes is to either grill the paste in the cooking process or to add an aliquot to the prepared main dish, which is then boiled – all such practices over and above the salting step, should be sufficient to kill any parasite stages. The risk in their consumption and the associated food safety concerns would, however, rise dramatically if the unprocessed, fermented or raw products were added directly to a dish; such is the practice in many Asian states where a fish sauce or lightly processed aquatic product such as brined crabs are added directly to salads or to rice without a cooking step. The finding of insect parts in several of the pastes may call for general improvements in food hygiene, restricting or preventing the access of insects to the pastes. The study does highlight that very little is known of the fish parasite fauna of Myanmar, which for the 11 species of fish considered here is 1 parasite, *Gnathostoma spinigerum* – an important zoonotic nematode of man. A further 24 zoonotic species are known from the 11 hosts and these may be present in Myanmar. Having an understanding on the prevalence of these latter species may help support the medical industry in their local diagnosis and treatment.

Acknowledgements

We thank the inland component of Myanmar Sustainable Aquaculture Programme (MYSAP), funded by the European Union (EU) and the German Federal Ministry of Economic Development and Cooperation (BMZ) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, for the receipt of the pastes and for this diagnostic contract. MYSAP Inland is implemented by WorldFish Myanmar, under a GIZ grant agreement.

References

Hotez, P. & Herricks, J. (2015) One million deaths by parasites. *PLoS Blogs*, posted 16 January 2015. https://blogs.plos.org/speakingofmedicine/2015/01/16/one-million-deaths-parasites/

Llarena-Reino, M., Pineiro, C., Antonio, J., Outerino, L., Vello, C., Gonzalez, A.F. & Pascual, S. (2015) Optimization of the pepsin digestion method for anisakids inspection in the fishing industry. *Veterinary Parasitology*, **191**, 276-283.

Torgerson, P.R., Devleesschauwer, B., Praet, N., Speybroeck, N., Willingham, A.L., Kasuga, F., *et al.* (2015) World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: a data synthesis. *PLoS Med*., **12** (12): e1001920. doi:10.1371/journal.pmed.1001920

Table 1. The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Acanthocephalans Heteracanthocephalidae								
Sachalinorhynchus sp.	n	n	n	n	y	n	n	n
Acanthocephalans Neoechinorhynchidae								
Dispiron heteroacanthus Khan & Bilqees, 1985	n	n	n	n	y	n	n	n
Neoechinorhynchus formosanus (Harada, 1938)	n	n	n	n	y	n	n	n
Neoechinorhynchus gibsoni Khan & Bilqees, 1989	n	n	n	n	y	n	n	n
Acanthocephalans Polymorphidae								
Corynosoma sp.	n	n	n	n	n	n	n	C. strumosum
Polymorphus sp.	n	n	n	n	n	n	n	n
Acanthocephalans Quadrigyridae								
Acanthogyrus acanthogyrus Thapar, 1927	n	n	n	n	y	n	n	n
Acanthogyrus guptai Gupta & Verma, 1976	n	n	n	n	y	n	n	n
Acanthogyrus (Acanthosentis) tilapiae (Baylis, 1948)	n	n	y	n	n	n	n	n
Acanthosentis betwai Tripathi, 1959	n	n	n	n	y	n	n	n
Pallisentis kalriai Khan & Bilqees, 1985	n	n	n	n	y	n	n	n
Pallisentis nagpurensis (Bhalerao, 1931)	n	n	y	n	n	n	n	n
Pallisentis ophiocephali Saeed & Bilqees, 1973	n	n	y	n	n	n	n	n
Pallisentis rexus Wongkham & Whitfield, 1999	n	n	y	n	n	n	n	n
Pallisentis (Demidueterospinus) ophiocephali (Tharpar, 1931)	n	n	y	n	n	n	n	n
Pallisentis (Pallisentis) gaboes (MacCallum, 1918)	n	n	y	n	n	n	n	n
Pallisentis (Pallisentis) nagpurensis (Bhalerao, 1931)	n	n	y	n	n	n	n	n
Cestodes Bothriocephalidae								
Bothriocephalus cuspidatus Cooper, 1917	n	n	y	n	n	n	n	n
Bothriocephalus teleostei Malhotra, 1984	n	n	n	n	y	n	n	n
Circumonchobothrium khami Shinde, 1976	n	n	y	n	n	n	n	n
Polyonchobothrium sp.	n	n	y	n	n	n	n	n
Senga ophiocephalina Tseng, 1933	n	n	y	n	y	n	n	n
Senga pathankotensis Duggal & Bedi, 1989	n	n	n	n	y	n	n	n
Senga striatus Rehana & Bilqees, 1979	n	n	y	n	n	n	n	n

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Taphrobothrium japonense Luhe, 1899	n	n	y	n	n	n	n	n
Cestodes Caryophyllaeidae								
Capingentoides moghei Pandey, 1973	n	n	y	n	n	n	n	n
Lytocestus fossilisi (Gupta, 1961)	n	n	y	n	n	n	n	n
Cestodes Dasyrhynchidae								
Callitetrarhynchus gracilis (Rudolphi, 1819)	n	n	n	n	n	n	n	n
Callitetrarhynchus speciosus (Linton, 1897)	n	n	n	n	n	n	n	n
Cestodes Diphyllobothriidae								
Ligula intestinalis (Linnaeus, 1758)	y	n	n	n	y	n	n	y
Cestodes Otobothriidae								
Otobothrium cysticum (Mayer, 1842)	n	n	n	n	n	n	n	n
Cestodes Prosobothriidae								
Prosobothrium spp. larva	n	n	n	n	n	n	n	n
Cestodes Proteocephalidae								
Gangesia bengalensis (Southwell, 1913)	n	n	n	n	y	n	n	n
Gangesia rohitae Shinde, Mahajan & Begum, 1999	n	n	n	n	y	n	n	n
Cestodes Pterobothriidae								
Pterobothrium interruptum (Rudolphi, 1819)	n	n	n	n	n	n	n	n
Cestodes Triaenophoridae								
Anchistrocephalus sp.	n	n	y	n	n	n	n	n
Nematodes Ascaridoidea								
Angusticaecum singhi (Gupta & Gupta, 1977)	n	n	n	n	n	n	n	n
Anisakis simplex (Rudolphi, 1809)	n	n	n	n	n	n	n	y
Contracaecum sp.	n	y	y	n	n	n	n	y
Contracaecum engraulisi Gupta & Srivastava, 1984	n	n	n	y	n	n	n	n
Goezia alii Kaur & Khera, 1991	n	n	y	n	n	n	n	n
Goezia taunsai Zaidi & Khan, 1975	n	n	n	n	n	n	n	n
Hysterothylacium sp.	n	n	n	n	n	n	n	y
Hysterothylacium krishnai Rajyalakshmi, 1993	n	y	n	n	n	n	n	n
Pseudoterranova sp. larva	n	n	n	n	n	n	n	y

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Pulchrascaris secunda (Chandler, 1935)	n	n	n	n	n	n	n	n
Terranova sp. (larva)	n	n	n	n	n	n	n	y
Terranova trichiuri (Chandler, 1935)	n	n	n	n	n	n	n	n
Nematodes Camallanoidea								
Camallanides sp.	n	n	n	n	n	n	n	n
Camallanides hemidenta Majumdar, 1965	n	n	y	n	n	n	n	n
Camallanus adamsi Bashirullah, 1974	n	n	y	n	n	n	n	n
Camallanus adamsia Bashirullah, 1973	n	n	y	n	n	n	n	n
Camallanus anabantis Pearse, 1933	n	y	n	n	n	n	n	n
Camallanus carangis Olsen, 1954	n	n	n	n	n	n	n	n
Camallanus dollfusi Bashirullah & Khan, 1973	n	n	n	n	n	n	n	n
Camallanus fernandoi (Yeh, 1960)	n	n	y	n	n	n	n	n
Camallanus gibsonia Bashirullah, 1973	n	n	y	n	n	n	n	n
Camallanus intestinalus Bashirullah, 1974	n	n	y	n	n	n	n	n
Camallanus kollerensis Rajyalakshmi, 1994	n	n	y	n	n	n	n	n
Camallanus kulasirii (Yeh, 1960)	n	y	n	n	n	n	n	n
Camallanus marinus Schmidt & Kuntz, 1969	n	n	n	n	n	n	n	n
Camallanus ophiocephali (Shendge & Deshmukh, 1977)	n	n	y	n	n	n	n	n
Camallanus pearsei (Yeh, 1960)	n	y	n	n	n	n	n	n
Camallanus sweeti Moorthy, 1937	n	y	n	n	n	n	n	n
Camallanus testudineusi Gupta & Verma, 1978	n	y	n	n	n	n	n	n
Camallanus thaparus Sahay & Narayan, 1968	n	n	y	n	n	n	n	n
Camallanus (Zeylanema) anabantis Pearse, 1933	n	y	n	n	n	n	n	n
Neocamallanus ophicephali (Pearce, 1933)	n	n	y	n	n	n	n	n
Neocamallanus singhi Ali, 1957	n	n	y	n	n	n	n	n
Neocamallanus sp.	n	n	y	n	n	n	n	n
Neozeylanema bahli Sahay, 1976	n	y	n	n	n	n	n	n
Paracamallanus karachiensis Sood, 1989	n	n	y	n	n	n	n	n
Paracamallanus lucknowensis (Gupta & Bakshi, 1979)	n	n	y	n	n	n	n	n

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Paracamallanus sp.	n	n	y	n	n	n	n	n
Paracamallanus sweeti (Moorthy, 1937)	n	n	y	n	n	n	n	n
Paracamallanus thapari (Agrawal & Misra, 1978)	n	n	y	n	n	n	n	n
Procamallanus daccai Gupta, 1959	n	n	y	n	n	n	n	n
Procamallanus eswarii Rajyalakshmi, 1997	n	n	y	n	n	n	n	n
Procamallanus intestinecolas (Bashirullah, 1973)	n	n	y	n	n	n	n	n
Procamallanus mysti Karve, 1952	n	n	y	n	n	n	n	n
Procamallanus notopteri (Bashirullah & Hafizuddin, 1973)	n	n	y	n	n	n	n	n
Procamallanus pakistanii (Siddiqi & Khattak, 1984)	n	n	y	n	n	n	n	n
Procamallanus rohitai Rajyalakshmi & Lakshmi, 1995	n	n	n	n	y	n	n	n
Procamallanus spiculogubernaculus Agarwal, 1958	n	n	y	n	n	n	n	n
Spirocamallanus inglisi Bashirullah & Hafizuddin, 1973	n	n	y	n	n	n	n	n
Spirocamallanus intestinicolas (Bashirullah, 1973)	n	n	y	n	n	n	n	n
Spirocamallanus notopteri Bashirullah & Hafizuddin, 1973	n	n	y	n	n	n	n	n
Spirocamallanus olsenia Bashirullah, 1973	n	n	y	n	n	n	n	n
Zeylanema anabantis (Pearse, 1933)	n	y	n	n	n	n	n	n
Zeylanema bidigitalis Bashirullah, 1973	n	y	n	n	n	n	n	n
Zeylanema pearsei Yeh, 1960	n	y	n	n	n	n	n	n
Nematodes Dioctophymatoidea								
Eustrongylides sp. larva	n	n	y	n	n	n	n	y
Nematodes Gnathostomatoidea								
Echinocephalus sp.	n	n	y	n	n	n	n	n
Gnathostoma sp.	n	n	y	n	y	n	n	y
Gnathostoma spinigerum Owen, 1836	n	y	y	n	n	n	y (catfish sp.)	y
Nematodes Habronematoidea								
Metabronema notopteri Karve & Naik, 1951	n	n	n	n	n	n	n	n
Pseudoproleptus gomtii Gupta & Bakshi, 1984	n	n	n	n	n	n	n	n
Pseudoproleptus notopteri Chakravarty and Majumdar, 1962	n	n	n	n	n	n	n	n
Pseudoproleptus satendrai Sahay, 1966	n	n	n	n	n	n	n	n
Pseudoproleptus thapari Gupta & Naiyer, 1993	n	n	n	n	n	n	n	n

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Pseudoproleptus vestibulus Khera, 1953	n	n	n	n	n	n	n	n
Spinitectus agrawali Verma, 1971	n	n	n	n	n	n	n	n
Spinitectus alii Kalyankar, 1970	n	n	n	n	n	n	n	n
Spinitectus bengalensis Chakravarty, Sain & Majumdar, 1961	n	n	n	n	n	n	n	n
Spinitectus gomalensis Siddiqi & Khattak, 1984	n	n	n	n	n	n	n	n
Spinitectus mastacembeli Karve & Naik, 1951	n	n	n	n	n	n	n	n
Spinitectus notopteri Karve & Naik, 1951	n	n	n	n	n	n	n	n
Spinitectus pandharinathi Kalyankar, 1973	n	n	y	n	n	n	n	n
Spinitectus thapari Ali, 1956	n	n	n	n	n	n	n	n
Nematodes Seuratoidea								
Buckleynema channai Gupta & Srivastava, 1983	n	n	y	n	n	n	n	n
Buckleynema notopteri Gupta & Srivastava, 1983	n	n	n	n	n	n	n	n
Cucullanus gonii Khan, Bilqees & Rehana Ghazi, 1991	n	n	n	n	y	n	n	n
Cucullanus khalili Khan, Bilqees & Rehana Ghazi, 1991	n	n	n	n	y	n	n	n
Indocucullanus jalnaensis Kalyankar, 1971	n	n	n	n	y	n	n	n
Indocucullanus (Indocucullanus) jalnaensis Kalyankar, 1971	n	n	n	n	y	n	n	n
Metaquimperia madhuai Sood	n	y	n	n	n	n	n	n
Neocucullanus indica Gupta & Naiyer, 1992	n	n	y	n	n	n	n	n
Paragendria sp.	n	n	n	n	n	n	n	n
Paragendria madhuai (Sood, 1973)	n	n	y	n	n	n	n	n
Paragendria wallagonia (Sood, 1968)	n	y	n	n	n	n	n	n
Nematodes Thelazioidea								
Heptachona sindica Akram, 1988	n	n	n	n	n	n	n	n
Rhabdochona alii Kalyankar, 1972	n	n	n	n	y	n	n	n
Rhabdochona chitalai Gupta & Srivastava, 1982	n	n	n	n	n	n	n	n
Rhabdochona labeonis Kalyankar, 1972	n	n	n	n	y	n	n	n
Rhabdochona nemacheli Rautela & Malhotra, 1981	n	n	n	n	y	n	n	n
Rhabdochona sarana Karve & Naik, 1951	n	n	n	n	y	n	n	n
Rhabdochona sp.	n	n	n	n	n	n	n	n
Nematodes Trichinelloidea								

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Capillaria sp.	n	n	n	n	n	n	n	y (4+ spp.)
Pseudocapillaria (Discocapillaria) margolisi De & Maity, 1996	y	n	n	n	n	n	n	n
Trematodes Allocreadiidae								
Allocreadium handiai (Pande, 1937)	n	y	n	n	n	n	n	n
Allocreadium kalriai Khan & Bilqees, 1990	n	n	y	n	n	n	n	n
Allocreadium mehrai Gupta, 1956	n	n	y	n	n	n	n	n
Allocreadium minutum Banerjee & Chandra, 1993	n	y	n	n	n	n	n	n
Trematodes Clinostomidae								
Clinstomatidae gen.	n	y	n	n	n	n	n	n
Clinostomoides brieni Dollfus, 1950	n	n	y	n	n	n	n	n
Clinostomum complanatum (Rudolphi, 1810)	n	n	y	n	n	n	n	y
Clinostomum indicum	n	n	n	n	n	n	n	n
Clinostomum mastacembali	n	n	n	n	n	n	n	n
Clinostomum philippinensis Velasquez, 1960	n	n	y	n	n	n	n	n
Clinostomum sp. metacercaria	n	n	y	n	n	n	n	y
Euclinostomum heterostomum (Rudolphi, 1809)	n	n	y	n	n	n	n	n
Euclinostomum multicaecum Tubangui & Masilungan, 1935	n	n	y	n	n	n	n	n
Trematodes Cryptogonimidae								
Pseudocryptogonimus pakistanensis Kahn & Biqees, 1990	n	n	n	n	y	n	n	n
Trematodes Derogenidae								
Genarchopsis goppo Ozaki, 1925	n	y	n	n	n	n	n	n
Trematodes Diplostomidae								
Diplostomulum sp. metacercaria	n	n	y	n	n	n	n	y (1 sp.)
Neodiplostomum sp. metacercaria	n	n	y	n	n	n	n	y (1 sp.)
Posthodiplostomum grayii (Verma, 1936)	n	y	y	n	n	n	n	n
Posthodiplostomum sp. metacerc.	n	n	y	n	n	n	n	n
Trematodes Echinostomatidae								
Singhia thapari (Singh, 1953)	n	n	n	n	n	n	n	n
Trematodes Fellodistomidae								

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Proctoeces maculatus (Looss, 1901)	n	n	n	n	y	n	n	n
Trematodes Gorgoderidae	n	n	y	n	n	n	n	
Phyllodistomum folium (Olfers, 1816)	n	n	y	n	n	n	n	n
Trematodes Hemiuridae								
Ectenurus papillatus Khan & Bilqees, 1990	n	n	n	n	y	n	n	n
Lecithochirium acutum Chauhan, 1945	n	n	n	n	n	n	n	n
Lecithochirium microstomum Chandler, 1935	n	n	n	n	n	n	n	n
Plerurus digitatus (Looss, 1899)	n	n	n	n	n	n	n	n
Sterrhurus branchialis Stunkard & Nigrelli, 1934	n	n	n	n	n	n	n	n
Trematodes Heterophyidae								
Centrocestus caninus Leiper, 1913	n	y	y	n	n	n	n	y
Centrocestus formosanus (Nishigori, 1924)	y	n	n	n	n	n	n	y
Haplorchis pumilio (Looss, 1896)	n	n	y	n	n	n	n	y
Haplorchis taichui (Nishigori, 1926)	y	n	y	n	n	n	n	y
Haplorchis yokogawai (Katsuta, 1932)	y	n	y	n	n	n	n	y
Procerovum calderoni (Africa & Garcia, 1935)	n	y	y	n	n	n	n	y
Procerovum varium (Onji & Nishio, 1916)	n	y	n	n	n	n	n	y
Stellantchasmus falcatus Onji & Nishio, 1915	n	y	n	n	n	n	n	y
Trematodes Isoparorchiidae								
Isoparorchis hypselobagri (Billet, 1898)	n	n	y	n	n	n	n	y
Isoparorchis pakistanicus	n	n	y	n	n	n	n	n
Trematodes Lecithodendriidae								
Pleurogenoides notopteri Bashirullah & Hafizuddin, 1973	n	n	n	n	n	n	n	n
Trematodes Lepocreadiidae								
Opechona pyriforme (Linton, 1900)	n	n	n	n	n	n	n	n
Trematodes Monorchiidae								
Asymphylodora sp.	n	y	n	n	n	n	n	n
Lasiotocus rohitai Bilqees & Khan, 1990	n	n	n	n	y	n	n	n
Trematodes Opecoelidae								

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*A. mola*	*Anabas testudineus*	*Channa striata*	*Coilia ramcarati*	*Labeo rohita*	*Mystus cavasius*	Myanmar	Human
Neopecoelina saharanpurensis Gupta, 1955	n	y	n	n	n	n	n	n
Opegaster minima (Tubangui, 1928)	n	n	y	n	n	n	n	n
Trematodes Opisthorchiidae								
Allogomtiotrema attu (Gupta, 1955)	n	n	y	n	n	n	n	n
Opisthorchis bilabiata Khan & Bilqees, 1990	n	n	n	n	y	n	n	n
Opisthorchis caninus	n	n	n	n	y	n	n	n
Opisthorchis gurdaspurensis Duggal & Harlean Bedi, 1989	n	n	n	n	y	n	n	n
Trematodes Plagiorchiidae								
(Plagiorchid metacercaria)	n	y	y	n	n	n	n	y (4 sp)
Encyclometra colubrimurorum (Rudolphi, 1819)	n	n	y	n	n	n	n	n
Trematodes Prosogonotrematidae								
Prosogonotrema nickoli	n	n	n	n	y	n	n	n
Trematodes Strigeidae								
Neascus sp. metac.	n	n	n	n	y	n	n	n
Trematodes Transversotrematidae								
Transversotrema patialense (Soparkar, 1924)	y	n	n	n	n	n	n	n

Colour code to the table

Parasite group organised by class and family levels

Parasite known from the literature in that host

Parasite of zoonotic potential and its corresponding host

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Acanthocephalans Heteracanthocephalidae							
Sachalinorhynchus sp.	n	n	n	n	n	n	n
Acanthocephalans Neoechinorhynchidae							
Dispiron heteroacanthus Khan & Bilqees, 1985	n	n	n	n	n	n	n
Neoechinorhynchus formosanus (Harada, 1938)	n	n	n	n	n	n	n
Neoechinorhynchus gibsoni Khan & Bilqees, 1989	n	n	n	n	n	n	n
Acanthocephalans Polymorphidae							
Corynosoma sp.	n	n	n	y	n	n	C. strumosum
Polymorphus sp.	n	n	n	y	n	n	n
Acanthocephalans Quadrigyridae							
Acanthogyrus acanthogyrus Thapar, 1927	n	n	n	n	n	n	n
Acanthogyrus guptai Gupta & Verma, 1976	n	n	n	n	n	n	n
Acanthogyrus (Acanthosentis) tilapiae (Baylis, 1948)	n	n	n	n	n	n	n
Acanthosentis betwai Tripathi, 1959	n	n	n	n	n	n	n
Pallisentis kalriai Khan & Bilqees, 1985	n	n	n	n	n	n	n
Pallisentis nagpurensis (Bhalerao, 1931)	n	n	n	n	n	n	n
Pallisentis ophiocephali Saeed & Bilqees, 1973	n	n	n	n	n	n	n
Pallisentis rexus Wongkham & Whitfield, 1999	n	n	n	n	n	n	n
Pallisentis (Demidueterospinus) ophiocephali (Tharpar, 1931)	n	n	n	n	n	n	n
Pallisentis (Pallisentis) gaboes (MacCallum, 1918)	n	n	n	n	n	n	n
Pallisentis (Pallisentis) nagpurensis (Bhalerao, 1931)	n	n	n	n	n	n	n
Cestodes Bothriocephalidae							
Bothriocephalus cuspidatus Cooper, 1917	n	n	n	n	n	n	n
Bothriocephalus teleostei Malhotra, 1984	n	n	n	n	n	n	n
Circumonchobothrium khami Shinde, 1976	n	n	n	n	n	n	n
Polyonchobothrium sp.	n	n	n	n	n	n	n
Senga ophiocephalina Tseng, 1933	n	n	n	n	n	n	n
Senga pathankotensis Duggal & Bedi, 1989	n	n	n	n	n	n	n
Senga striatus Rehana & Bilqees, 1979	n	n	n	n	n	n	n

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Taphrobothrium japonense Luhe, 1899	n	n	n	n	n	n	n
Cestodes Caryophyllaeidae							
Capingentoides moghei Pandey, 1973	n	n	n	n	n	n	n
Lytocestus fossilisi (Gupta, 1961)	n	n	n	n	n	n	n
Cestodes Dasyrhynchidae							
Callitetrarhynchus gracilis (Rudolphi, 1819)	n	n	n	y	n	n	n
Callitetrarhynchus speciosus (Linton, 1897)	n	n	n	y	n	n	n
Cestodes Diphyllobothriidae							
Ligula intestinalis (Linnaeus, 1758)	n	n	n	n	n	n	y
Cestodes Otobothriidae							
Otobothrium cysticum (Mayer, 1842)	n	n	n	y	n	n	n
Cestodes Prosobothriidae							
Prosobothrium spp. larva	n	n	n	y	n	n	n
Cestodes Proteocephalidae							
Gangesia bengalensis (Southwell, 1913)	n	n	n	n	n	n	n
Gangesia rohitae Shinde, Mahajan & Begum, 1999	n	n	n	n	n	n	n
Cestodes Pterobothriidae							
Pterobothrium interruptum (Rudolphi, 1819)	n	n	n	y	n	n	n
Cestodes Triaenophoridae							
Anchistrocephalus sp.	n	n	n	n	n	n	n
Nematodes Ascaridoidea							
Angusticaecum singhi (Gupta & Gupta, 1977)	n	n	n	y	n	n	n
Anisakis simplex (Rudolphi, 1809)	n	n	n	y	n	n	y
Contracaecum sp.	n	n	n	y	n	n	y
Contracaecum engraulisi Gupta & Srivastava, 1984	n	n	n	n	n	n	n
Goezia alii Kaur & Khera, 1991	n	n	n	n	n	n	n
Goezia taunsai Zaidi & Khan, 1975	y	n	n	n	n	n	n
Hysterothylacium sp.	n	n	n	y	n	n	y
Hysterothylacium krishnai Rajyalakshmi, 1993	n	n	n	n	n	n	n
Pseudoterranova sp. larva	n	n	n	y	n	n	y

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Pulchrascaris secunda (Chandler, 1935)	n	n	n	y	n	n	n
Terranova sp. (larva)	n	n	n	y	n	n	y
Terranova trichiuri (Chandler, 1935)	n	n	n	y	n	n	n
Nematodes Camallanoidea							
Camallanides sp.	n	n	n	y	n	n	n
Camallanides hemidenta Majumdar, 1965	n	n	n	n	n	n	n
Camallanus adamsi Bashirullah, 1974	n	n	n	n	n	n	n
Camallanus adamsia Bashirullah, 1973	n	n	n	n	n	n	n
Camallanus anabantis Pearse, 1933	n	n	n	n	n	n	n
Camallanus carangis Olsen, 1954	n	n	n	y	n	n	n
Camallanus dollfusi Bashirullah & Khan, 1973	n	n	n	y	n	n	n
Camallanus fernandoi (Yeh, 1960)	n	n	n	n	n	n	n
Camallanus gibsonia Bashirullah, 1973	n	n	n	n	n	n	n
Camallanus intestinalus Bashirullah, 1974	n	n	n	n	n	n	n
Camallanus kollerensis Rajyalakshmi, 1994	n	n	n	n	n	n	n
Camallanus kulasirii (Yeh, 1960)	n	n	n	n	n	n	n
Camallanus marinus Schmidt & Kuntz, 1969	n	n	n	y	n	n	n
Camallanus ophiocephali (Shendge & Deshmukh, 1977)	n	n	n	n	n	n	n
Camallanus pearsei (Yeh, 1960)	n	n	n	n	n	n	n
Camallanus sweeti Moorthy, 1937	n	n	n	n	n	n	n
Camallanus testudineusi Gupta & Verma, 1978	n	n	n	n	n	n	n
Camallanus thaparus Sahay & Narayan, 1968	n	n	n	n	n	n	n
Camallanus (Zeylanema) anabantis Pearse, 1933	n	n	n	n	n	n	n
Neocamallanus ophicephali (Pearce, 1933)	n	n	n	n	n	n	n
Neocamallanus singhi Ali, 1957	n	n	n	n	n	n	n
Neocamallanus sp.	n	n	n	n	n	n	n
Neozeylanema bahli Sahay, 1976	n	n	n	n	n	n	n
Paracamallanus karachiensis Sood, 1989	n	n	n	n	n	n	n
Paracamallanus lucknowensis (Gupta & Bakshi, 1979)	n	n	n	n	n	n	n

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Paracamallanus sp.	n	n	n	n	n	n	n
Paracamallanus sweeti (Moorthy, 1937)	n	n	n	n	n	n	n
Paracamallanus thapari (Agrawal & Misra, 1978)	n	n	n	n	n	n	n
Procamallanus daccai Gupta, 1959	n	n	n	n	n	n	n
Procamallanus eswarii Rajyalakshmi, 1997	n	n	n	n	n	n	n
Procamallanus intestinecolas (Bashirullah, 1973)	n	n	n	n	n	n	n
Procamallanus mysti Karve, 1952	y	n	n	n	n	n	n
Procamallanus notopteri (Bashirullah & Hafizuddin, 1973)	y	n	n	n	n	n	n
Procamallanus pakistanii (Siddiqi & Khattak, 1984)	y	n	n	n	n	n	n
Procamallanus rohitai Rajyalakshmi & Lakshmi, 1995	n	n	n	n	n	n	n
Procamallanus spiculogubernaculus Agarwal, 1958	n	n	n	n	n	n	n
Spirocamallanus inglisi Bashirullah & Hafizuddin, 1973	y	n	n	n	n	n	n
Spirocamallanus intestinicolas (Bashirullah, 1973)	n	n	n	n	n	n	n
Spirocamallanus notopteri Bashirullah & Hafizuddin, 1973	y	n	n	n	n	n	n
Spirocamallanus olsenia Bashirullah, 1973	n	n	n	n	n	n	n
Zeylanema anabantis (Pearse, 1933)	n	n	n	n	n	n	n
Zeylanema bidigitalis Bashirullah, 1973	n	n	n	n	n	n	n
Zeylanema pearsei Yeh, 1960	n	n	n	n	n	n	n
Nematodes Dioctophymatoidea							
Eustrongylides sp. larva	n	n	n	n	n	n	y
Nematodes Gnathostomatoidea							
Echinocephalus sp.	n	n	n	n	n	n	n
Gnathostoma sp.	n	n	n	n	n	n	y
Gnathostoma spinigerum Owen, 1836	n	n	n	n	n	y (catfish sp.)	y
Nematodes Habronematoidea							
Metabronema notopteri Karve & Naik, 1951	y	n	n	n	n	n	n
Pseudoproleptus gomtii Gupta & Bakshi, 1984	y	n	n	n	n	n	n
Pseudoproleptus notopteri Chakravarty and Majumdar, 1962	y	n	n	n	n	n	n
Pseudoproleptus satendrai Sahay, 1966	y	n	n	n	n	n	n
Pseudoproleptus thapari Gupta & Naiyer, 1993	y	n	n	n	n	n	n

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Pseudoproleptus vestibulus Khera, 1953	y	n	n	n	n	n	n
Spinitectus agrawali Verma, 1971	y	n	n	n	n	n	n
Spinitectus alii Kalyankar, 1970	y	n	n	n	n	n	n
Spinitectus bengalensis Chakravarty, Sain & Majumdar, 1961	y	n	n	n	n	n	n
Spinitectus gomalensis Siddiqi & Khattak, 1984	y	n	n	n	n	n	n
Spinitectus mastacembeli Karve & Naik, 1951	y	n	n	n	n	n	n
Spinitectus notopteri Karve & Naik, 1951	y	n	n	n	n	n	n
Spinitectus pandharinathi Kalyankar, 1973	n	n	n	n	n	n	n
Spinitectus thapari Ali, 1956	y	n	n	n	n	n	n
Nematodes Seuratoidea							
Buckleynema channai Gupta & Srivastava, 1983	n	n	n	n	n	n	n
Buckleynema notopteri Gupta & Srivastava, 1983	y	n	n	n	n	n	n
Cucullanus gonii Khan, Bilqees & Rehana Ghazi, 1991	n	n	n	n	n	n	n
Cucullanus khalili Khan, Bilqees & Rehana Ghazi, 1991	n	n	n	n	n	n	n
Indocucullanus jalnaensis Kalyankar, 1971	n	n	n	n	n	n	n
Indocucullanus (Indocucullanus) jalnaensis Kalyankar, 1971	n	n	n	n	n	n	n
Metaquimperia madhuai Sood	n	n	n	n	n	n	n
Neocucullanus indica Gupta & Naiyer, 1992	n	n	n	n	n	n	n
Paragendria sp.	y	n	n	n	n	n	n
Paragendria madhuai (Sood, 1973)	n	n	n	n	n	n	n
Paragendria wallagonia (Sood, 1968)	n	n	n	n	n	n	n
Nematodes Thelazioidea							
Heptachona sindica Akram, 1988	n	n	n	y	n	n	n
Rhabdochona alii Kalyankar, 1972	n	n	n	n	n	n	n
Rhabdochona chitalai Gupta & Srivastava, 1982	y	n	n	n	n	n	n
Rhabdochona labeonis Kalyankar, 1972	n	n	n	n	n	n	n
Rhabdochona nemacheli Rautela & Malhotra, 1981	n	n	n	n	n	n	n
Rhabdochona sarana Karve & Naik, 1951	n	n	n	n	n	n	n
Rhabdochona sp.	y	n	n	n	n	n	n
Nematodes Trichinelloidea							

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Capillaria sp.	n	n	n	y	n	n	y (4+ spp.)
Pseudocapillaria (Discocapillaria) margolisi De & Maity, 1996	n	n	n	n	n	n	n
Trematodes Allocreadiidae							
Allocreadium handiai (Pande, 1937)	n	n	n	n	n	n	n
Allocreadium kalriai Khan & Bilqees, 1990	n	n	n	n	n	n	n
Allocreadium mehrai Gupta, 1956	n	n	n	n	n	n	n
Allocreadium minutum Banerjee & Chandra, 1993	n	n	n	n	n	n	n
Trematodes Clinostomidae							
Clinstomatidae gen.	n	n	n	n	n	n	n
Clinostomoides brieni Dollfus, 1950	n	n	n	n	n	n	n
Clinostomum complanatum (Rudolphi, 1810)	n	n	n	n	n	n	y
Clinostomum indicum	y	n	n	n	n	n	n
Clinostomum mastacembali	y	n	n	n	n	n	n
Clinostomum philippinensis Velasquez, 1960	n	n	n	n	n	n	n
Clinostomum sp. metacercaria	n	n	n	n	n	n	y
Euclinostomum heterostomum (Rudolphi, 1809)	n	n	n	n	n	n	n
Euclinostomum multicaecum Tubangui & Masilungan, 1935	n	n	n	n	n	n	n
Trematodes Cryptogonimidae							
Pseudocryptogonimus pakistanensis Kahn & Biqees, 1990	n	n	n	n	n	n	n
Trematodes Derogenidae							
Genarchopsis goppo Ozaki, 1925	n	n	n	n	n	n	n
Trematodes Diplostomidae							
Diplostomulum sp. metacercaria	n	n	n	n	n	n	y (1 sp.)
Neodiplostomum sp. metacercaria	n	n	n	n	n	n	y (1 sp.)
Posthodiplostomum grayii (Verma, 1936)	n	n	n	n	n	n	n
Posthodiplostomum sp. metacerc.	n	n	n	n	n	n	n
Trematodes Echinostomatidae							
Singhia thapari (Singh, 1953)	y	n	n	n	n	n	n
Trematodes Fellodistomidae							

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Proctoeces maculatus (Looss, 1901)	n	n	n	n	n	n	n
Trematodes Gorgoderidae	n	n	n	n	n	n	
Phyllodistomum folium (Olfers, 1816)	n	n	n	n	n	n	n
Trematodes Hemiuridae							
Ectenurus papillatus Khan & Bilqees, 1990	n	n	n	n	n	n	n
Lecithochirium acutum Chauhan, 1945	n	n	n	y	n	n	n
Lecithochirium microstomum Chandler, 1935	n	n	n	y	n	n	n
Plerurus digitatus (Looss, 1899)	n	n	n	y	n	n	n
Sterrhurus branchialis Stunkard & Nigrelli, 1934	n	n	n	y	n	n	n
Trematodes Heterophyidae							
Centrocestus caninus Leiper, 1913	n	n	n	n	n	n	y
Centrocestus formosanus (Nishigori, 1924)	y	y	n	n	n	n	y
Haplorchis pumilio (Looss, 1896)	n	n	n	n	n	n	y
Haplorchis taichui (Nishigori, 1926)	n	n	n	n	n	n	y
Haplorchis yokogawai (Katsuta, 1932)	n	y	n	n	n	n	y
Procerovum calderoni (Africa & Garcia, 1935)	n	n	n	n	n	n	y
Procerovum varium (Onji & Nishio, 1916)	n	n	n	n	n	n	y
Stellantchasmus falcatus Onji & Nishio, 1915	n	n	n	n	n	n	y
Trematodes Isoparorchiidae							
Isoparorchis hypselobagri (Billet, 1898)	n	n	n	n	n	n	y
Isoparorchis pakistanicus	n	n	n	n	n	n	n
Trematodes Lecithodendriidae							
Pleurogenoides notopteri Bashirullah & Hafizuddin, 1973	y	n	n	n	n	n	n
Trematodes Lepocreadiidae							
Opechona pyriforme (Linton, 1900)	n	n	n	y	n	n	n
Trematodes Monorchiidae							
Asymphylodora sp.	n	n	n	n	n	n	n
Lasiotocus rohitai Bilqees & Khan, 1990	n	n	n	n	n	n	n
Trematodes Opecoelidae							

Table 1 (cont.). The known parasite fauna of the fish species included in the fish pastes under study here. Records are from the published literature. Their occurrence in Myanmar and ability to infect man is also recorded.

Parasite	*Notopterus notopterus*	*Puntius chola*	*Setipinna wheeleri*	*Trichiurus lepturus*	*Trichopodus pectoralis*	Myanmar	Human
Neopecoelina saharanpurensis Gupta, 1955	n	n	n	n	n	n	n
Opegaster minima (Tubangui, 1928)	n	n	n	n	n	n	n
Trematodes Opisthorchiidae							
Allogomtiotrema attu (Gupta, 1955)	n	n	n	n	n	n	n
Opisthorchis bilabiata Khan & Bilqees, 1990	n	n	n	n	n	n	n
Opisthorchis caninus	n	n	n	n	n	n	n
Opisthorchis gurdaspurensis Duggal & Harlean Bedi, 1989	n	n	n	n	n	n	n
Trematodes Plagiorchiidae							
(Plagiorchid metacercaria)	n	n	n	n	n	n	y (4 sp)
Encyclometra colubrimurorum (Rudolphi, 1819)	n	n	n	n	n	n	n
Trematodes Prosogonotrematidae							
Prosogonotrema nickoli	n	n	n	n	n	n	n
Trematodes Strigeidae							
Neascus sp. metac.	n	n	n	n	n	n	n
Trematodes Transversotrematidae							
Transversotrema patialense (Soparkar, 1924)	n	y	n	n	n	n	n

Colour code to the table

Parasite group organised by class and family levels

Parasite known from the literature in that host

Parasite of zoonotic potential and its corresponding host

Table 2. A summary of the structures found within the edible pastes originating from Myanmar.

Sample no.	Details	Aquatic species in the paste	Structures for identification recovered?	Notes
001	Small shrimp (krill) and salt	Of marine origin from an area close to the sea	No	No structures selected for identification
002	Small shrimp (krill) and salt	Of marine origin from an area close to the sea	YES	Structures not of parasitic nature
003	Small shrimp (krill) and salt	Of marine origin from an area close to the sea	YES	Structures not of parasitic nature
004	Small shrimp (krill) and salt	Of marine origin from an area close to the sea	YES	Crustacean pleopods - not parasitic. Image on photo on plate
005	Small shrimp (krill) and salt	Of marine origin from an area close to the sea	YES	Structures not of parasitic nature. Image included on photo plate.
006	Small shrimp and salt	Of marine origin from an area close to the sea	YES	Structures not of parasitic nature
007	Fish, salt, and cooked rice	Ribbon fish (Trichiurus lepturus); of marine origin	YES	Structures not of parasitic nature
008	fish, salt, and cooked rice	Mystus (Mystus cavasius); freshwater origin	YES	Bryozoan statoblast - can act as intermediate hosts for parasites but are not in themselves parasitic
009	Fish, salt, and cooked rice	Snakeskin gourami ("nga pyin sa lat") (Trichopodus pectoralis); freshwater - a wild fish that enters aquaculture ponds	YES	Structure rejected - tissue mass
010	Fish, salt, and cooked rice	Snakehead ("nga yan") (Channa striata)	YES (?)	Egg recovered but it is not known if this of parasite origin. See image on photo plate.
011	Fish, salt, and cooked rice	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*); freshwater, wild	na	No sample
012	Fish, salt, and cooked rice	Mixture of Ramcarat grenadier anchovy ("mi than twe") (*Coilia ramcariti*) and Burma hairfin anchovy ("nga pya") (*Setipinna wheeleri*); marine origin	na	No sample
013	Fish and salt	Mixture of fish scraps (i.e. head, bones), mixed with other types of fish paste (marine and freshwater origin)	na	No sample

Table 2. A summary of the structures found within the edible pastes originating from Myanmar.

Sample no.	Details	Aquatic species in the paste	Structures for identification recovered?	Notes
014	Fish and salt	Snakehead ("nga yant") (*Channa striata*); large size	No	No structures selected for identification
015	Fish and salt	Climbing perch ("nga byae ma") (Anabas testudineus) and bronze featherback ("nga phe") (Notopterus notopterus)	YES	Hind part of a nematode recovered - the head missing and therefore identification very difficult. In relatively good condition. Species unknown but not likely to be *Gnathostoma* . Image included on the photo plate.
016A	Fish and salt	Barb ("nga kor mar") - species of barb unknown	YES	Young cyst. Image included on the photo plate
O16B	Fish and salt	Barb ("nga kor mar") - species of barb unknown	YES	Young cyst. Image included on the photo plate
017A	Fish and salt	Mixture of different fish species		No structures selected for identification
017B	Fish and salt	Mixture of different type of fish species.	YES	Two egg structures. See images on the attached plate
018A	Fish and salt	Ribbon fish ("nga dagon") (Trichiurus lepturus) and Burma hairfin anchovy ("nga pya") (Setipinna wheeleri); marine origin	YES	Bryozoan statoblast recovered - not parasitic.
018B	Fish and salt	Ribbon fish ("nga dagon") (*Trichiurus lepturus*) and Burma hairfin anchovy ("nga pya") (*Setipinna wheeleri*); marine origin	YES	Degenerative tissue mass - dismissed as non parasitic - see photo
019	Fish and salt	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*); freshwater	No	No structures for identification
020	Fish and salt	Mystus (*Mystus cavasius*); freshwater	YES	Young eggs. Insect parts. Elongated egg. Seed pod. Copepod - most likely free-living. Pollen grain. Images included on the photo plate
021	Fish and salt	Rohu ("nga myait chin") (*Labeo rohita*)	No	No structures for identification
022A	Fish, salt and cooked rice	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*); freshwater	No	No structures for identification
022B	Fish, salt and cooked rice	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*); freshwater	No	No structures for identification
023A	Fish, salt, and cooked rice	Snakehead ("nga yant") (*Channa striata*)	No	No structures for identification
023B	Fish, salt, and cooked rice	Snakehead ("nga yant") (*Channa striata*)	No	No structures for identification

Table 2. A summary of the structures found within the edible pastes originating from Myanmar.

Sample no.	Details	Aquatic species in the paste	Structures for identification recovered?	Notes
024A	Fish, salt, and cooked rice	Climbing perch ("nga byae ma") (*Anabas testudineus*); freshwater	YES	Seed pod; psorospermium (?; thick haline wall; see photo); two degenerated eggs - species not determinable.
024B	Fish, salt, and cooked rice	Climbing perch ("nga byae ma") (*Anabas testudineus*); freshwater	YES	Structure appears like a spent egg but is most likely a degenerating fish scale
025A	Fish, salt, and cooked rice	Mystus (*Mystus cavasius*); freshwater	No	No structures for identification
025B	Fish, salt, and cooked rice	Mystus (*Mystus cavasius*); freshwater	No	No structures for identification
026A	Shrimp and salt	Shrimp (krill) from the Delta	YES	Shrimp pleopods
026B	Shrimp and salt	Shrimp (krill) from the Delta	YES	Shrimp pleopods
027A	Shrimp and salt	Shrimp (krill) from the Delta	YES	Shrimp pleopods
027B	Shrimp and salt	Shrimp (krill) from the Delta	YES	Shrimp pleopods
028A	Shrimp and salt	Shrimp (krill) from Myeik	YES	Shrimp pleopods
029A	Fish and salt	Mixture of different fish species.	No	No structures for identification
029B	Fish and salt	Mixture of different fish species. The heads and bones of the fish are ground up and mixed with the different types of fish paste	YES	Insect parts.
030A	Fish, salt, and cooked rice	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*); freshwater; large size.	YES	Numerous insect pupae and larvae. An immature egg (species non determinable) was also found.
030B	Fish, salt, and cooked rice	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*); freshwater; large size. The head is removed, gutted and descaled.	YES	Insect parts and an egg (not identifiable)

Table 2. A summary of the structures found within the edible pastes originating from Myanmar.

Sample no.	Details	Aquatic species in the paste	Structures for identification recovered?	Notes
031	Fish, cooked rice, salt, and old fermented fish product (1% of the total ingredients)	Mola carplet ("nga bel phyu") (*Amblypharyngodon mola*) and swamp barb ("nga khone ma") (*Puntius chola*); freshwater	No	No structures for identification
032	Fish, cooked rice, salt, and old fermented fish product (1% of the total ingredients)	Mola carplet ("nga bel phyu") (*Amblypharyngodon mola*) and swamp barb ("nga khone ma") (*Puntius chola*); freshwater	YES	Insect parts (see photo) and degenerated tissue mass
033	Fish meat only, cooked rice, salt, and old fermented fish product (1% of the total ingredients)	Rohu Labeo ("nga myit chin") (*Labeo rohita*); freshwater	YES	Fibre (see photo) and tissue mass (possibly a parasite cyst but appears to be devoid of content).

Structures may be parasitic

Structures found likely to be parasitic in nature

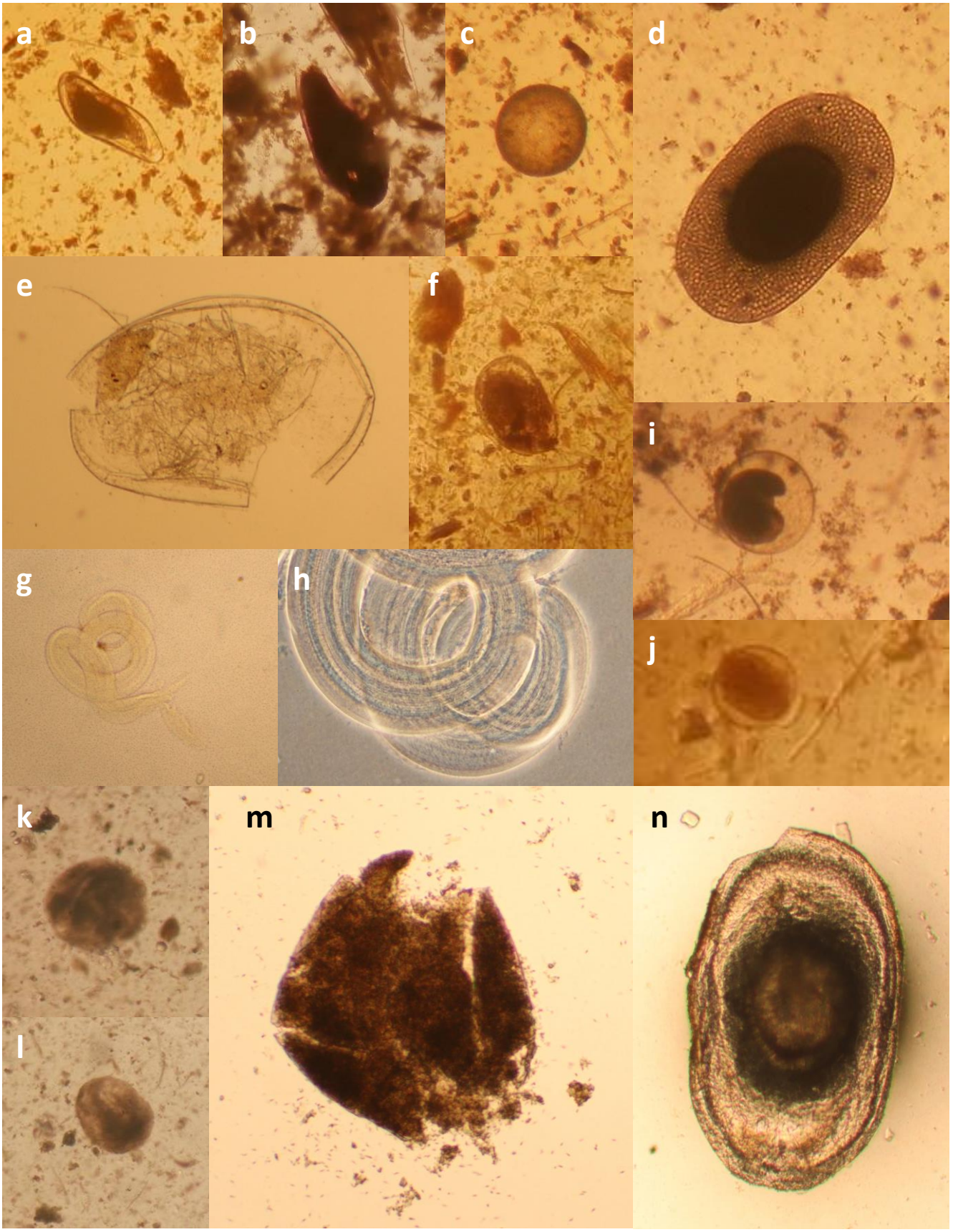

Plate one. a = Sample 4 (krill paste); **b** = Sample 4 (krill paste); **c** = Sample 5 (krill paste) – immature cyst (?); **d** = Sample 8 (paste containing *Mystus cavasius*) - a bryozoan statoblast; **e** = Sample 10 (paste containing *Channa striata*) – a ruptured egg (species indeterminate); **f** = Sample 10 (paste containing *Channa striata*) – egg *in situ* in filtrate; **g + h** = Sample 15 (paste containing *Anabas testudineus* + *Notopterus notopterus*) – hind part of a nematode – species cannot be determined; **i** = Sample 16A (paste containing "barb") – egg structure; **j** = Sample 16B (paste containing "barb") – egg structure; **k-m** = Sample 17B (paste containing a mix of fish species) – tissue masses approximating thin shelled immature eggs; **n** = Sample 18A (paste containing *T. lepturus* + *S. wheeleri*) – degenerating ruptured statoblast which a raised centre – not parasitic.

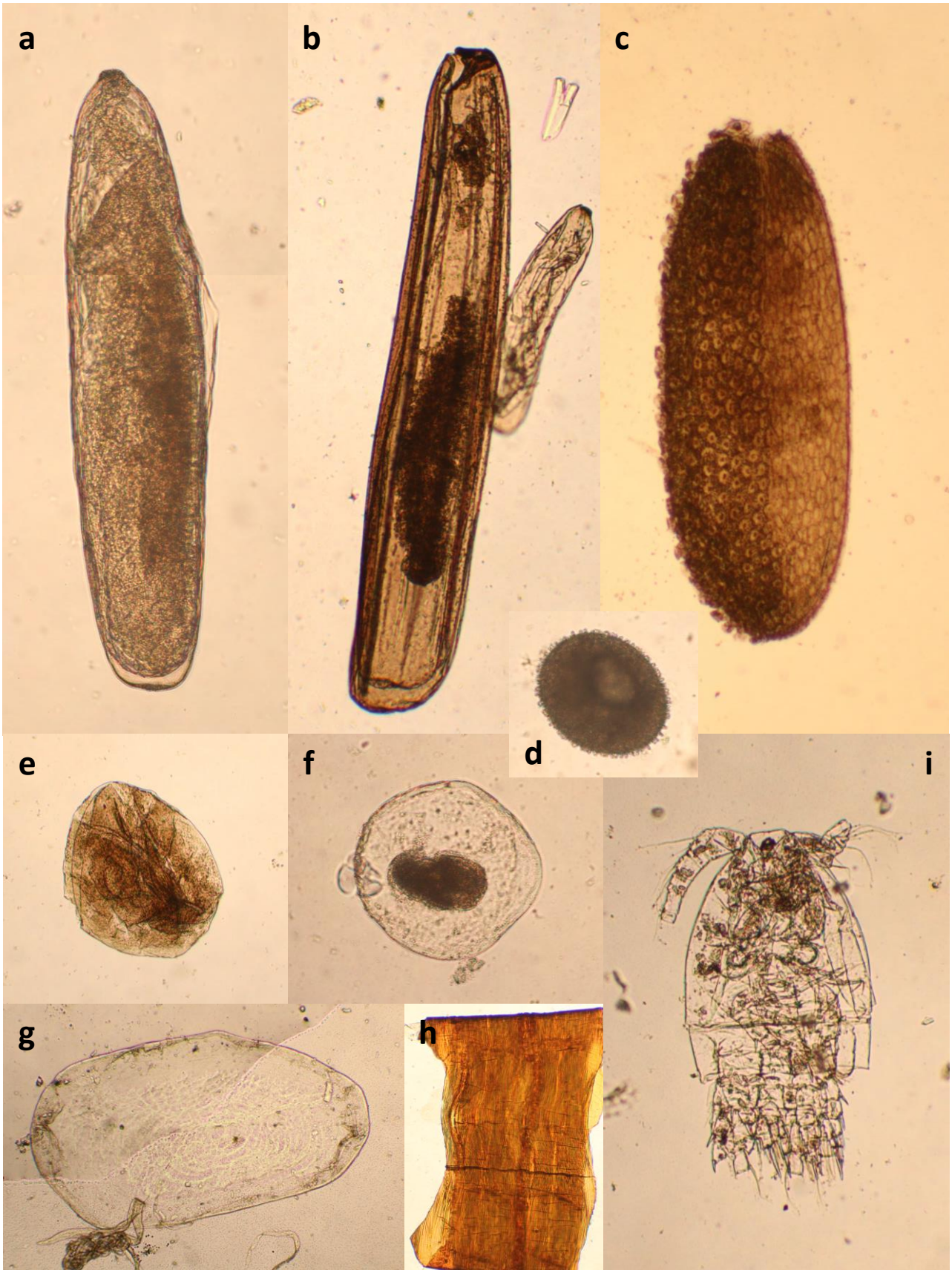

Plate two. Structures harvested from Sample 20 (a paste containing *Mystus cavasius*). **a** = A composite image of an egg, two identified and one of two found in the sample, with a prominent terminal process; **b** = Egg (smaller of the two structures) next to what is believed to be a plant-based structure; **c** = One of several small grass (?) seeds; **d** = Pollen grain; **e** = Thin-walled, immature egg-like structure; **f** = Small cyst like structure – one of three found in this sample; **g** = Degenerating fish scale – one first examination it appears to have an egg structure but under phase some annulations can be seen; **h** = Part of an insect; **i** = Free-living (?) copepod.

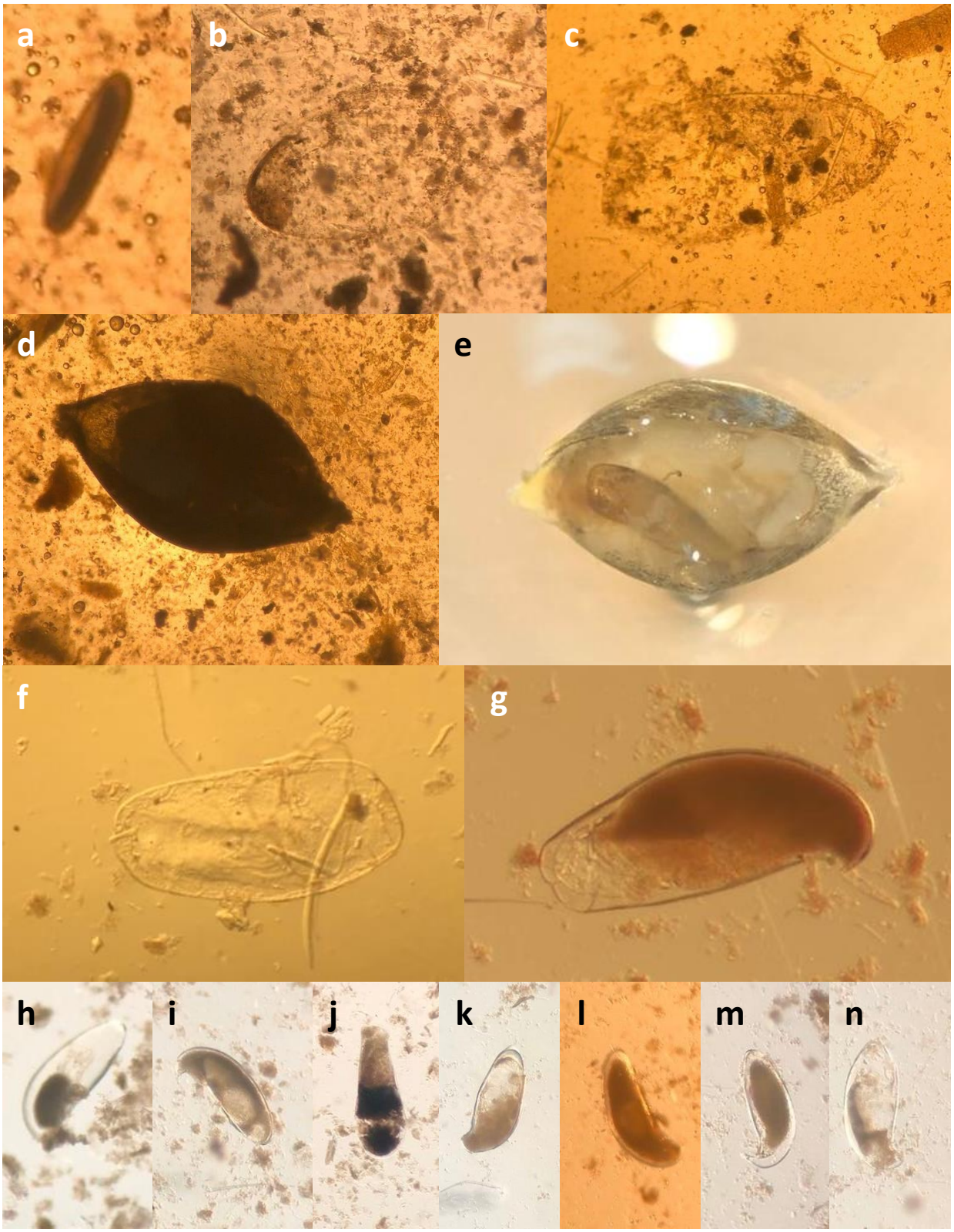

Plate three. a = Sample 24A (a sample containing *Anabas testudineus*) – structure is reminiscent of psorospermium with a thick haline wall; **b + c** = Sample 24A – degenerating egg structure; **d + e** = Sample 24A – seed pod as seen in situ in the filtrate and under different lighting conditions; **f** = Sample 24B (a sample containing *Anabas testudineus*) – degenerating fish scale; **g** = Sample 26B (krill paste) - pleopod; **h-j** = Sample 26A (krill paste) - pleopods; **k-n** = Sample 27A (krill paste) – pleopods.

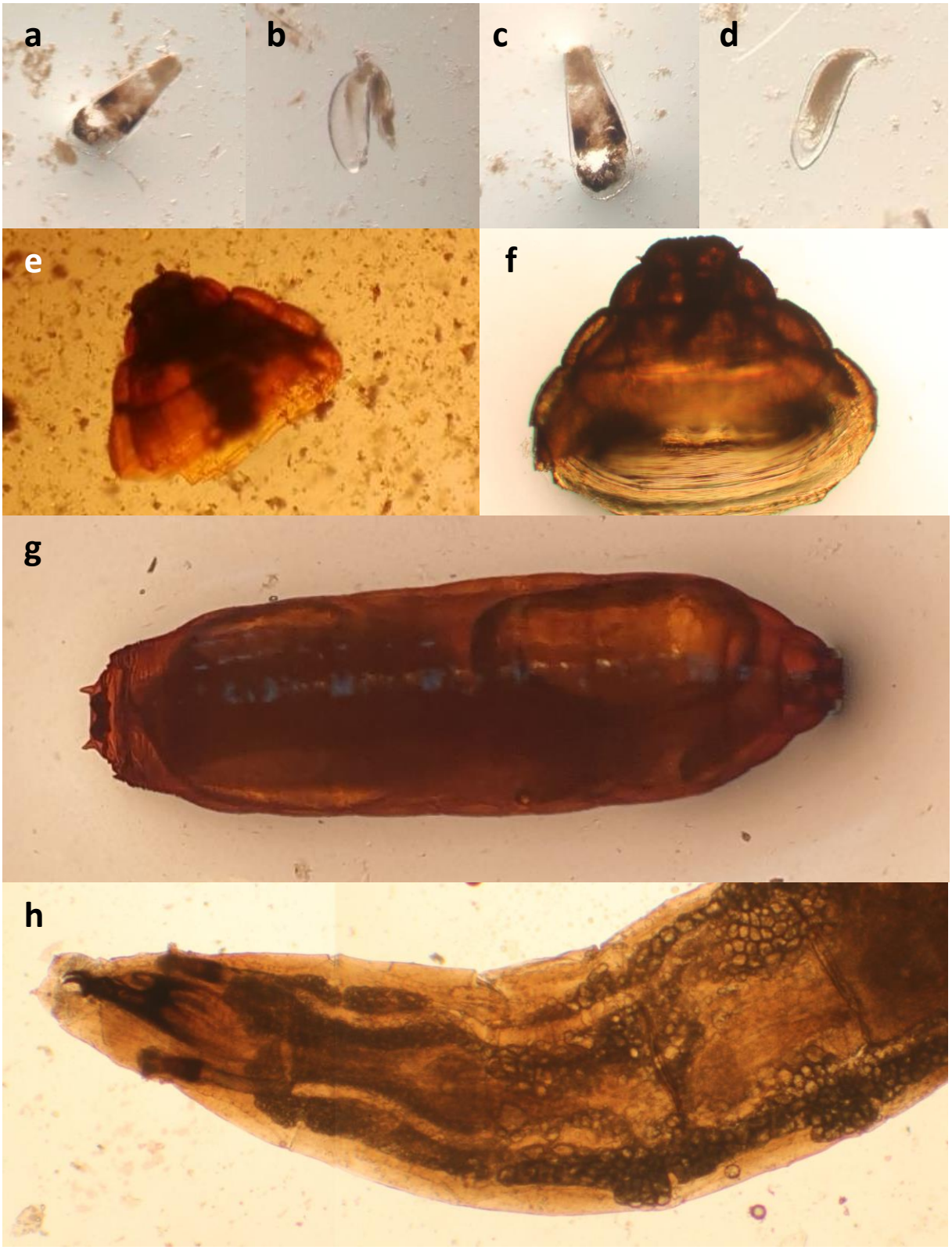

Plate four. a-d = Sample 28A (krill sample) - pleopods; **e + f** = Sample 29B – insect cuticle; **g + h** = Sample 30A (paste containing *Trichopodus pectoralis*) - insect pupae and larvae – numerous specimens were found in the sample.

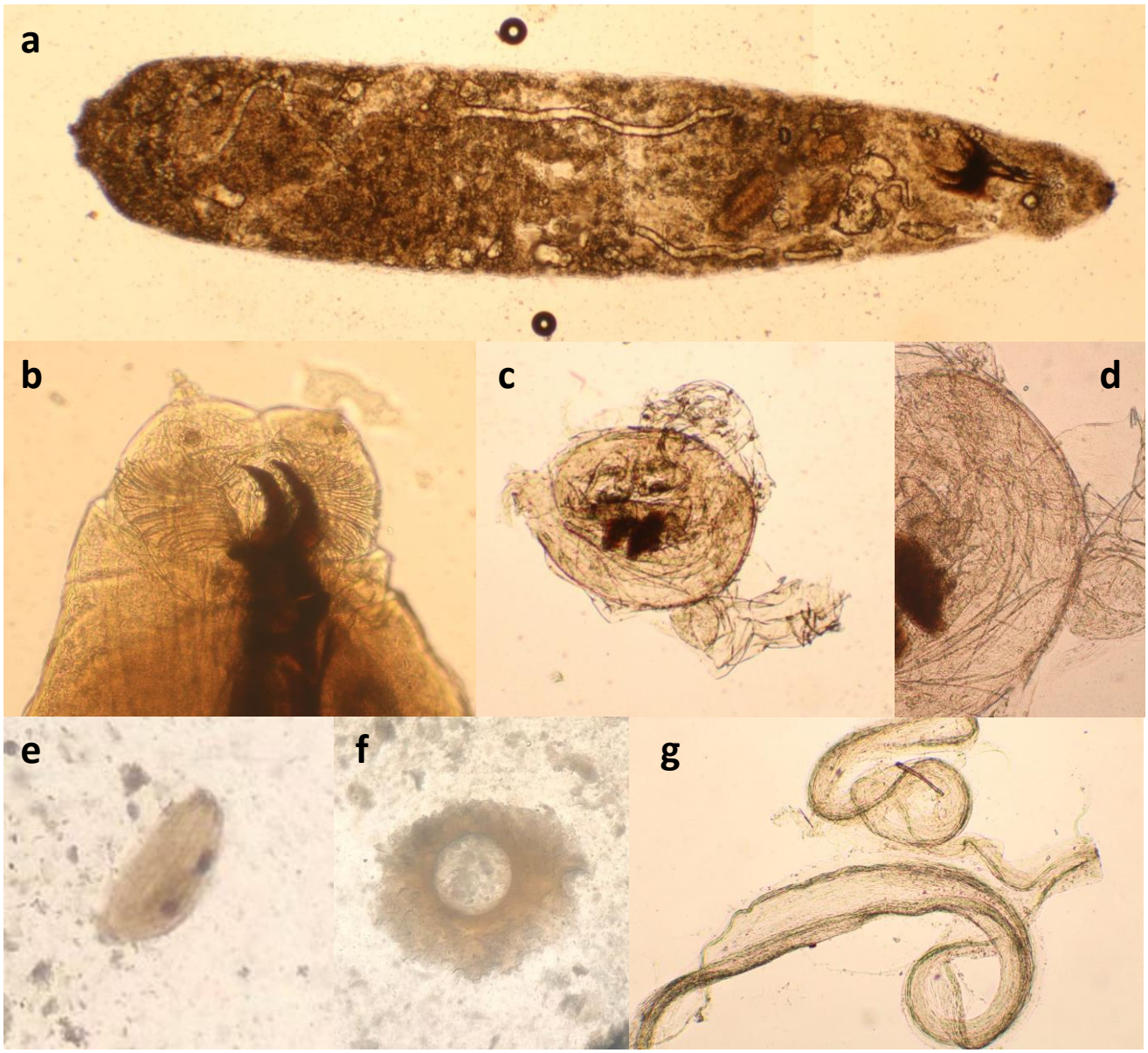

Plate five. a-b = Sample 30A (paste containing *Trichopodus pectoralis*) – insect pupae and larvae. Numerous specimens were found in the sample; **c + d** = Sample 30B (paste containing *Trichopodus pectoralis*) – degenerated egg; **e** = Sample 32 (paste containing *Amblypharyngodon mola* + *Puntius chola*) – insect cuticle; **f + g** = Sample 33 (paste containing *Labeo rohita*) – immature, degenerating parasite cyst (?) and fibre initially thought to be shrivelled nematode..

Fish and Shrimp Paste Sample Information

INLAND MYSAP Project

Sample no.	Date collected	Name of seller	Phone number	Stall no. and name	Traditional name of the product	Price MMK/viss (1 viss = 1.63 kg)	Place of production	Main ingredients
001	8/21/2019	Daw Cho Cho Win	973113659	Tiger Fish Paste Seller, Thiri Mingalar Market	Myin Ngapi (Shrimp Paste)	1,800 MMK/viss	Kadaung Kuni, Ayeyarwady	Small shrimp (krill) and salt. The amount of each ingredient is not known.
002						2,300 MMK/viss		Small shrimp (krill) and salt - the volume of each ingredient is not known. The quantity of salt is less compared to the product above making it a little sweeter.
003						2,500 MMK/viss		Small shrimp (krill) and salt. The volume of each ingredient is not known. The quantity of salt is less compared to the product above making it sweeter.
004						3,500 MMK/viss	Myeik, Tanitharyi	Small shrimp (krill) and salt
005						4,500 MMK/viss		
006						1,600 MMK/viss	Kadaung Kuni, Ayeyarwady	Small shrimp, salt
007					Ye gyo Ngapi (Fish paste)	1,600 MMK/viss		Fish, salt, and cooked rice
008						2,300 MMK/viss	Bogalay, Ayeyarwady	Fish, salt, and cooked rice. 10 viss of fish and salt mixture bought from Bayint Naung + 1 viss of cooked rice + 1 viss of coarse salt
009						2,300 MMK/viss	Maubin and Pantanaw in the Ayeyawardy, Delta	

Sample no.	Date collected	Name of seller	Phone number	Stall no. and name	Traditional name of the product	Price MMK/viss (1 viss = 1.63 kg)	Place of production	Main ingredients
010	8/22/2019	Daw Cho Cho Win	973113659	Tiger Fish Paste Seller, Thiri Mingalar Market	Ye gyo Ngapi (Fish paste)	5,000 MMK/viss	Maubin and Pantanaw in the Ayeyawardy, Delta	Fish, salt, and cooked rice. 10 viss of fish and salt mixture bought from Bayint Naung + 1 viss of cooked rice + 1 viss of coarse salt
011						1,600 MMK/viss		
012						1,300 MMK/viss	Bogalay and Kadaung Kuni in the Ayeyarwady, Delta	
013					Myin Ngapi (Shrimp Paste)	1,000 MMK/viss	Sold by dried fish producer from Le Daung Ka in Yangon area. Also in Thiyi Nipin Chaung- a place in Yangon that does SME production	Fish and salt
014	8/22/2019	Daw San San Maw	95145932	Thura Shop	Ye gyo Ngapi (Fish paste)	5,000 MMK/viss	Maubin	
015						2,300 MMK/viss		
016A						1,700 MMK/viss		
O16B						1,700 MMK/viss		
017A				Thura Shop (2nd shop)		1,000 MMK/viss		
017B						1,000 MMK/viss		

Sample no.	Date collected	Name of seller	Phone number	Stall no. and name	Traditional name of the product	Price MMK/viss (1 viss = 1.63 kg)	Place of production	Main ingredients
018A	8/22/2019	Daw San San Maw	95145932	Thura Shop (2nd shop)	Ye gyo Ngapi (Fish paste)	1,600 MMK/viss	Kadaung Kuni, Ayeyarwady	Fish and salt
018B						1,600 MMK/viss		
019	8/22/2019	Htoo Myat	9950633424	No Name	Ye gyo Ngapi (Fish paste)	1,600 MMK/viss	Not known	
020						2,500 MMK/viss		
021	8/22/2019	Zaw Moe Hlaing	95041023	Thiri Moe	Ye gyo Ngapi (Fish paste)	4,000 MMK/viss	Maubin	
022A	8/23/2019	U Kyaw Moe Thu	95153249	Bayint Naung wholesale shop	Ye gyo Ngapi (Fish paste)	1,300 MMK/viss	Nyaungdon, Ayeywarwady, Delta	Fish, salt and cooked rice
022B						1,300 MMK/viss		
023A						3,200 MMK/viss		
023B						3,200 MMK/viss		
024A						2,000 MMK/viss		
024B						2,000 MMK/viss		
025A						1,800 MMK/viss		
025B						1,800 MMK/viss		
026A	8/23/2019	U Kyaw Moe Thu	95153249	Bayint Naung wholesale shop	Myin Ngapi (Shrimp Paste)	1,500 MMK/viss	Ayeyarwady, Delta	Shrimp and salt
026B						1,500 MMK/viss		

Sample no.	Date collected	Name of seller	Phone number	Stall no. and name	Traditional name of the product	Price MMK/viss (1 viss = 1.63 kg)	Place of production	Main ingredients
027A	8/23/2019	U Kyaw Moe Thu	95153249	Bayint Naung wholesale shop	Myin Ngapi (Shrimp Paste)	900 MMK/viss	Naung Mi village, Pyapon	Shrimp and salt
027B						900 MMK/viss	Naung Mi village, Pyapon	
028						12,000 MMK/viss	Maang, Myeik	
029A	8/23/2019	U Kyaw Moe Thu	95153249	Bayint Naung wholesale shop	Ye gyo Ngapi (Fish paste)	1,300 MMK/viss	Naung Mi village, Pyapon	Fish and salt
029B						1,300 MMK/viss		

Sample no.	Date collected	Name of seller	Phone number	Stall no. and name	Traditional name of the product	Price MMK/viss (1 viss = 1.63 kg)	Place of production	Main ingredients
030A	8/23/2019	U Kyaw Moe Thu	95153249	Bayint Naung wholesale shop	Ye gyo Ngapi (Fish paste)	1,800 MMK/viss	Nyaungdon, Ayeywarwady, Delta	Fish, salt, and cooked rice
030B						1,800 MMK/viss		
031	9/5/2019	Not indicated	Not indicated	Mezali, Nyaungdon Township, Ayeyarwady, Delta	Fermented fish / pickled fish	250 MMK/ piece	4 miles from Mezali, Nyaungdon	Fish, cooked rice, salt, and old fermented fish product (1% of the total ingredients)
032						250 MMK/ piece		Fish, cooked rice, salt, and old fermented fish product (1% of the total ingredients)
033						1,000 MMK/piece		Fish flesh only, cooked rice, salt, and old fermented fish product (1% of the total ingredients)

Sample no.	Type of fish / shrimp	Methods of production	Date / time of production	Delivery Time/Date	Product shelf life
001	Marine origin; from an area near the sea	Salt is added to the shrimp but the whole process is not known. The product is bought from Bayint Naung main market (wholesale).	Not known	a week ago	5-6 months. It is packed in a sack. Each sack weighs 50 viss.
002					
003					
004	Marine origin	It is sundried then ground to a paste.			
005		1) Salt and shrimp are mixed together 2) Product is sundried 3) Then ground into a paste			
006	Marine origin; from an area near the sea	The salt is added to the shrimp but the whole process is not known The product is bought from Bayint Naung main market (wholesale)			
007	Ribbon fish ("nga dagon") (*Trichiurus lepturus*); of marine origin	1) It is bought as a fish and salt mixture - the fish are not yet soft at this stage; 2) Owner adds cooked rice into the fish and salt mixture then adds some additional coarse salt. Afterwards, it is mixed together. 3) Stored in a large, blue drum for 1-2 months then it is ready to be sold; no stirring needed while being stored. The drum is covered with bamboo with a rock on top.	Bought in April plus an additional 2 months of storage after which it is processed by the seller. It has been sold in the market for months.	NA	1 year
008	Mystus *(Mystus cavasius*); from freshwater e.g. a river				
009	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*). From freshwater; wild fish that enter aquaculture ponds.				

Sample no.	Type of fish / shrimp	Methods of production	Date / time of production	Delivery Time/Date	Product shelf life
010	Snakehead ("nga yan") (*Channa striata*)	1) It is bought as a fish and salt mixture - the fish are not yet soft at this stage; 2) Owner adds cooked rice into the fish and salt mixture then adds some additional coarse salt. Afterwards, it is mixed together. 3) Stored in a large, blue drum for 1-2 months then it is ready to be sold; no stirring needed while being stored. The drum is covered with bamboo with a rock on top.	Bought in April plus an additional 2 months of storage after which it is processed by the seller. It has been sold in the market for months.	NA	1 year
011	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*). From freshwater; wild fish.				
012	Mixture of Ramcarat grenadier anchovy ("mi than twe") (*Coilia ramcariti*) and Burma hairfin anchovy ("nga pya") (*Setipinna wheeleri*); marine origin.				
013	Mixture of scraps from different types of fish (head, bones) and mixed with other types of fish paste (marine and fresh water)	1) Scraps of fish are ground up (sold by dried fish producer from Le daung ka in the Yangon area) 2) The owner adds the different types of fish paste to the mixture and then this is sold.			
014	Snakehead ("nga yant") (*Channa striata*); large size	Not sure. It is delivered directly from Maubin.	Not known	3 months ago	1 year
015	Climbing perch ("nga byae ma") (*Anabas testudineus*) and bronze featherback ("nga phe") (*Notopterus notopterus*)				
016A	Barb ("nga kor mar") - species of barb unknown				
O16B					
017A	Mixture of different type of fish species. The heads and bones of the fish are ground and mixed with different types of fish paste				
017B					

Sample no.	Type of fish / shrimp	Methods of production	Date / time of production	Delivery Time/Date	Product shelf life
018A 018B	Ribbon fish ("nga dagon") (*Trichiurus lepturus*) and Burma hairfin anchovy ("nga pya") (*Setipinna wheeleri*); of marine origin	Not known	Not known	3 months ago	1 year
019	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*)	From Bayint Naung Market	Not known	Not sure	1 year
020	Mystus *(Mystus cavasius*); from freshwater e.g. a river				
021	Rohu ("nga myait chin") (*Labeo rohita*)	Not known. It is delivered directly from Maubin.	Not known	50 days ago	not known
022A 022B	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*). From freshwater; wild fish.	The specific production for this sample is not known but he is aware that there are two methods of production; A. Short process of production 1) Fish and salt are put in a container for 2 days. The mixture of fish and salt is pressed (100 viss fish and 20 viss salt). 2) Cooked rice (hot) is added to fish and salt mixture. Then mixed together. Left for 1 month before it is ready for selling. Shelf life 1-2 months. B. Longer process of production 1) Fish and salt are put in a container for 1 month. The mixture of fish and salt is pressed (100 viss fish and 40 viss salt). 2) Before adding cooked rice (not hot), the salt is removed.. Then add rice to the fish and salt mixture. The process is for 3-6 months before it is ready for selling. Shelf life is 1 year. Fish are washed, then salt is added; not gutted and descaled	Not known	Arrived a week ago. The product will be stored in the shop for 1-2 weeks before the batch is sold out.	2-3 years
023A 023B	Snakehead ("nga yant") (*Channa striata*)				
024A 024B	Climbing perch ("nga byae ma") (*Anabas testudineus*); freshwater				
025A 025B	Mystus (*Mystus cavasius*); from freshwater				
026A 026B	Shrimp (krill) from the Delta	Not known.	The processing started from the supplier in February.	Arrived 3 weeks ago.	1 year

Sample no.	Type of fish / shrimp	Methods of production	Date / time of production	Delivery Time/Date	Product shelf life
027A	Shrimp (krill) from the Delta	1) While in the sea, the caught shrimp (krill) are mixed with rock salt. Afterwards it is brought to the village. This is done during the fishing season which lasts for 50 days. 2) In the village, salt is added to the the shrimp and salt mixture. 3) Sundried for 7 hours. 4) Then ground using a machine; the capacity of the machine is from 10,000 viss-50,000 viss. The quality of the shrimp paste is based on the following: a) When the weather is not good and if during high tide, shrimp is not of good quality. While in low tide, it is of good quality because shrimp are alive. b) Sun drying- if there is too much heat, the shrimp paste is not good quality. c) Grinding - when water is used, it is not good quality. The shelf life is shorter. If it uses only fish sauce, it is better and the shelf life is for 1 year.	Not known	Arrived 3 weeks ago.	1 year
027B					
028	Shrimp (krill) from Myeik	1) The shrimp and salt (little amount) is mixed together. 2) The mixture is pressed by workers stepping on the paste instead of using a machine. The taste is sweet. The sea in Myeik is clear and clean hence a qood quality shrimp paste. Usual processing starts in October till March in the village.		It arrived 4 months ago. The batch will be sold out by September	3 years
029A	Mixture of different type of fish species. The heads and bones of the fish are ground up and then mixed with the different types of fish paste	The specific production for this sample is not known but he is aware that there are two methods of production; A. Short process of production 1) Fish and salt are put in a container for 2 days. The mixture of fish and salt is pressed (100 viss fish and 20 viss salt). 2) Cooked rice (hot) is added to fish and salt mixture. Then mixed together. Left for 1 month before it is ready for selling. Shelf life 1-2 months. B. Longer process of production 1) Fish and salt are put in a container for 1 month. The mixture of fish and salt is pressed (100 viss fish and 40 viss salt). 2) Before adding cooked rice (not hot), the salt is removed.. Then add rice to the fish and salt mixture. The process is for 3-6 months before it is ready for selling. Shelf life is 1 year. Fish are washed, then salt is added; not gutted and descaled	Not known	Arrived a week ago. The product will be stored in the shop for 1-2 weeks before the batch is sold out.	2-3 years
029B					

Sample no.	Type of fish / shrimp	Methods of production	Date / time of production	Delivery Time/Date	Product shelf life
030A	Mixture of different type of fish species. The heads and bones of the fish are grinded and mixed with the different types of fish paste	not known	Not known	Arrived a week ago. The product will be stored in the shop for 1-2 weeks before the batch is sold out.	*2-3 years*
030B	Snakeskin gourami ("nga pyin sa lat") (*Trichopodus pectoralis*). From freshwater, large size. The head is removed, the fish filleted and descaled				
031	Mola carplet ("nga bel phyu") (*Amblypharyngodon mola*) and swamp barb ("nga khone ma") (*Puntius chola*); freshwater	1) The fish is cleaned by cutting off the head, gutting and descaling it. Then washed. 2) The fish is then cut into smaller pieces, mixed with cooked rice, salt and old fermented fish. 3) Wrapped in a banana leaf.	9/4/2019		5 days-in normal outside temperature; 1 month if chilled in the fridge Usually after production of 2 days, it can be eaten raw
032	Mola carplet ("nga bel phyu") (*Amblypharyngodon mola*) and swamp barb ("nga khone ma") (*Puntius chola*); freshwater				3 days- in normal outside temperature; 1 month if chilled in the fridge Usually after production of 2 days, it can be eaten raw
033	Rohu Labeo ("nga myit chin") (*Labeo rohita*); freshwater				

Sample no.	Type of storage used	Ingredients added when stored in the shop	Place and method of storage	Constraints / challenges as a vendor that WF and DoF can support?	Usual practice of consumption	Can be contacted?	Photo Yes/ No
001	It is packed in a sack.	None	Stacked with other shrimp pastes. It is stored inside the market shop	No constraints; she has been in the business for 30 years	The product is added in any type of curry during cooking. After adding shrimp paste to the curry, it is allowed to simmer for a few minutes	Yes	Yes
002							
003							
004					2 ways of consuming the paste; a) The shrimp paste is grilled. After grilling, it is pounded, then chilli, onions, garlic, dried shrimps and other spices are added . This is called ngapi daung. b) Added to a curry when cooking, like a fish sauce, as a replacement for salt or monosodium glutamate (MSG).		
005							
006					The product is added to any type of curry during cooking. After adding the shrimp paste, the curry simmers for a few minutes		
007	Blue drum with a cover	None	Stored in the market	None	Water is added to the fish paste, then boiled. Then a little turmeric is added. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices.		
008							
009							

Sample no.	Type of storage used	Ingredients added when stored in the shop	Place and method of storage	Constraints / challenges as a vendor that WF and DoF can support?	Usual practice of consumption	Can be contacted?	Photo Yes/ No
010	Blue drum with a cover	None	Stored in the market	None	Water is added to the fish paste, then boiled. Then a little turmeric is added. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices.	Yes	Yes
011							
012							
013	Blue drum container with a cover						
014	It is stored in a blue drum container. When the market is closed, the shop is covered with large plastic cover. The containers are not individually covered.	None	Stored in the market	The price is getting higher. Before, it was 3,500 MMK only. There is now a low supply. When the batch of fish paste is sold out, she will not have a new supply.	Water is added to the fish paste, then boiled. Then a little turmeric is added. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices.	Yes	no
015							
016A				This year, the fish supply is not enough. It could be that the fish are getting rare.			
O16B							
017A				None			
017B							

Sample no.	Type of storage used	Ingredients added when stored in the shop	Place and method of storage	Constraints / challenges as a vendor that WF and DoF can support?	Usual practice of consumption	Can be contacted?	Photo Yes/ No
018A	It is stored in a blue drum container. When the market is closed, the shop is covered with large plastic cover. The containers are not individually covered.	None	Stored in the market	None	Water is added to the fish paste, then boiled. Then a little turmeric is added. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices.	Yes	no
018B							
019	Blue drum container					no	no
020							
021							
022A	Blue drum container. The containers are covered in metal grills with a large tarpaulin (plastic) sheet on top.	None	Stored in the shop	No challenges since the market of the product is Myanmar. Although it needs more investment in order to buy a larger amount of fish paste. It is better to store the product in large batches until April when it is in higher demand and it can be sold at a higher price.	Two ways of consuming the fish paste: * Add water to the fish paste then boil. Add a little turmeric. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices. *Few people prepare the fish paste by pounding it first using mortar and pestle. Then they add dried shrimp, garlic, onions and chillies. Fry altogether.	Yes	Yes
022B							
023A					Add water to the fish paste then boil. Add a little turmeric. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices.		
023B							
024A							
024B							
025A							
025B							
026A	Kept in a sack	None	Stored in the shop	There is a need of modern technology from Thailand or other countries. He can process a better quality shirmp paste that can be competitive in international market. Similar to	Shrimp paste is added in any type of curry when cooking, then it is allowed to simmer for a few minutes.	Yes	Yes
026B							

Sample no.	Type of storage used	Ingredients added when stored in the shop	Place and method of storage	Constraints / challenges as a vendor that WF and DoF can support?	Usual practice of consumption	Can be contacted?	Photo Yes/ No
027A 027B 028	Kept in a sack	None	Stored in the shop	Thai products. He can also sell it in a higher price. He knows a producer of fish sauce who has good modern machine from Thailand. With the help of Thai technician and his team has been trained so he now produces better and safe fish sauce .	Shrimp paste is added in any type of curry when cooking, then it is allowed to simmer for a few minutes.	Yes	Yes
029A 029B	Blue drum container. The containers are covered in metal grills with a large tarpaulin (plastic) sheet on top.	None	Stored in the shop	No challenges since the market of the product is Myanmar. Although it needs more investment in order to buy a larger amount of fish paste. It is better to store the product in large batch until April which is higher demand; it can be sold in higher price	Add water to the fish paste then boil. Put a little amount of turmeric. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices.	Yes	Yes

Sample no.	Type of storage used	Ingredients added when stored in the shop	Place and method of storage	Constraints / challenges as a vendor that WF and DoF can support?	Usual practice of consumption	Can be contacted?	Photo Yes/ No
030A	Blue drum container. The containers are covered in metal grills with a large tarpaulin (plastic) sheet on top.	None	Stored in the shop	No challenges since the market of the product is Myanmar. Although it needs more investment in order to buy a larger amount of fish paste. It is better to store the product in large batch until April which is higher demand; it can be sold in higher price	Two ways of consuming the fish paste: * Add water to the fish paste then boil. Put a little amount of turmeric. Then remove the bones and other parts of the fish that may be hard. Before serving, add chili and other spices. *Few people prepare the fish paste by pounding it first using mortar and pestle. Then add the dried shrimp, garlic, onions and chillies. Fry altogether.	Yes	Yes
030B							
031	Individually packed in banana leaf	None	Left hanging in the shop in normal outside temperature	Not known	Two ways of preparing for consumption A) The new ones (not yet sour) is usually eaten as it is; it is cut in smaller pieces then little oil is added with onions and garlic like a typical Burmese salad. B) Those products that have been stored longer (product is sour) is cut into small pieces then sauteed (fried with minimal amount of oil) with onion, garlic and some spices.	Not indicated	Not indicated
032	Individually packed in banana leaf and the outer covering is made of another type of leaf						
033	Individually packed in banana leaf						