1. 1m Opening
2. 1m Introduction – White Sea
   - 2.1. Historical
   - 2.2. Recent
     - 2.2.1. Subtidal
     - 2.2.2. Intertidal
3. 2mIntroduction – Notocotylidae
   - 3.1. Digeneans
   - 3.2. Phylogeny
   - 3.3. Originally dixenous
   - 3.4. Appearance
   - 3.5. Methods
   - 3.6. → outline of the talk
4. 2m Littorina parasites and Catatropis
   - 4.1. Found Cat. verr. (?) and found cerc. in Littorina – a cycle?
   - 4.2. But what about other "cycles"? Pseudocatatropis concept
   - 4.3. Finding in Onoba. Did not detect differences in adults.
   - 4.4. Type species?
   - 4.5. =Cryptic species
5. 2m Actual Littorina parasites and Tristriata
   - 5.1. What actually IS in Littorina
   - 5.2. ±clear species/genus, but distribution?
   - 5.3. =Phylogeography
6. 2m Notocotylus adults and Hydrobia
   - 6.1. Specificity
7. 3m Hydrobia and sibling species
8. 1m Conclusions and closing

±150 words per minute

1
Dear colleagues,
I am joining you today from St Petersburg, and these four days our science is marine parasitology!

2-1
The sea I will be focusing on is the White Sea. The sea is not big and special in having reduced salinity, but it is also special in terms of parasitology. Look at this map from early 16th century:
2-2
they have not realized it's linked to the Barents Sea, so it is depicted as a lake, but it says:
2-3
"The White Lake, where are numerous species of fish and birds". Which means, as we understand, numerous species of parasites.

Throughout the second half of the 20th century the White Sea was blooming as a region for parasitology research, and this goes on today. Just as a quick advertisement – a recent project led by my colleague Darya, on the subtidal communities. Wonderful team, a number of papers on trematodes from fished and marine mammals.
And the intertidal gets even more attention – you will hear about some aspects of this research tomorrow from Kirill Galaktionov. And for my talk today I chose one of the topics that are in progress: the study of the digenean family Notocotylidae.

3

Notocotylidae are parasitic flatworms from the group Digenea. They have a 2-host life cycle, and this is a primary character state – so we assume that their ancestors did not have a second intermediate host.
Notocotylids are quite common and have quite a recognizable appearance. Their sexual adults usually have papillae or ridges on the ventral side. Their cercariae usually have three eyespots and conspicuous excretory ducts filled with refractile granules.

I would like first to go through three (more or less complete, and at least published) stories that each highlight one of the Notocotylid features that we revealed. Then, I will share the last story that we are just starting to understand and that I find most exciting now, because of all its uncertainty. And I will try to finish with some family-wide considerations.

4

The periwinkles are the top choice of the White Sea parasitologists, and the first story starts with the X about what species could be the notocotylids from the Littorina species.

At the White Sea there were birds infected with Catatropis worms and periwinkles infected with notocotylids. Both were common, they co-occured, and the idea was that they are stages of a single life cycle. The species was called Catatropis verrucosa, and here we have a problem.

Because there also were two completely different ideas of Catatropis verrucosa life cycle. One with Bythinia, one with Lymnea. Doesn't seem possible.

The freshwater part of this puzzle resolved in the establishment of the new genus, Pseudocatatropis.

What did we find? Catatropis adults are indeed quite common, but the corresponding first intermediate hosts are snails Onoba aculeus.

We did not detect differences in adults. But other features allow distinction. So we are not supposed to call it cryptic species. But we see a trend: notocotylids can be very similar.

5

So what was that in periwinkles, so common and not a Catatropis? We found that these were life cycle stages of another species, Tristriata anatis. Here, we had less complications related to identifying the adult worms, but instead there was intrigue about geographic distribution. Is there the same species in North Atlantic and North Pacific? We analyzed variable DNA markers to outline phylogeography and found that the species is single, but genetic exchange is limited. Makes sense with current snail distribution and bird migrations. But in some warmer periods in the past it could be different. Notocotylid adults live long and can survive such a trip, if it occurred.

6

In fact we have later shown, although not as robustly, that at least one species of Notocotylidae, Notocotylus atlanticus, also has a range spanning from the White Sea and France to Japan.
I have explained how we understood two life cycles. But even just at the White Sea we saw more notocotylids than just these two. Clearly different adults – Notocotylus. There surely was an idea that this is Notocotylus attenuatus, another cosmopolitan "monsterous" species that everyone used to name anything similar.

We showed that the first intermediate hosts of this Notocotylus are hydrobiids. Which species is it? We found that they correspond to the species Notocotylus atlanticus, and this is our primary

hypothesis. But it's not so easy. The adults match, and they even seem distinct from the "N. attenuatus". But what about the hosts?

50 years ago, it would have looked neat: H. ventrosa here, H, salsa there. But there are no such Hydrobias anymore. This is the phylogeny of Truncatelloidea, and these are the distinct families. The question is, what is the degree of notocotylid specificity towards the first intermediate host?

Случаи паразитирования *Q. quinqueserialis* в моллюсках разных родов сем. Planorbidae подтверждены молекулярно-генетическими методами (Gagnon, Detwiler, 2019). При оценке трематодофауны моллюсков в Канаде один вид нотокотилид (не описанный, но выявленный по последовательностям гена *cox1*) был встречен в трех разных видах моллюсков из трех семейств надсем. Lymnaeoidea (Gordy et al., 2016).

OK, do we suppose that the specificity

7

In E. ventrosa we also found 2 other types of cercariae. They differ from N. atlanticus in their morphptype, the shape of the MCD. They also differ in how they treat potential encystment substrates: we did this experiment back in 2015. (graph) What are the species? One seemed clear: cercariae were Monostomi, which is characteristic of P. alveatum. This in fact was the only Notocotylid species known from both birds and molluscs at the White Sea, it's life cycle elucidated in 1954. We assumed it was P. alveatum, and later found the adult worms that match genetically and comply with P. alveatum diagnosis.

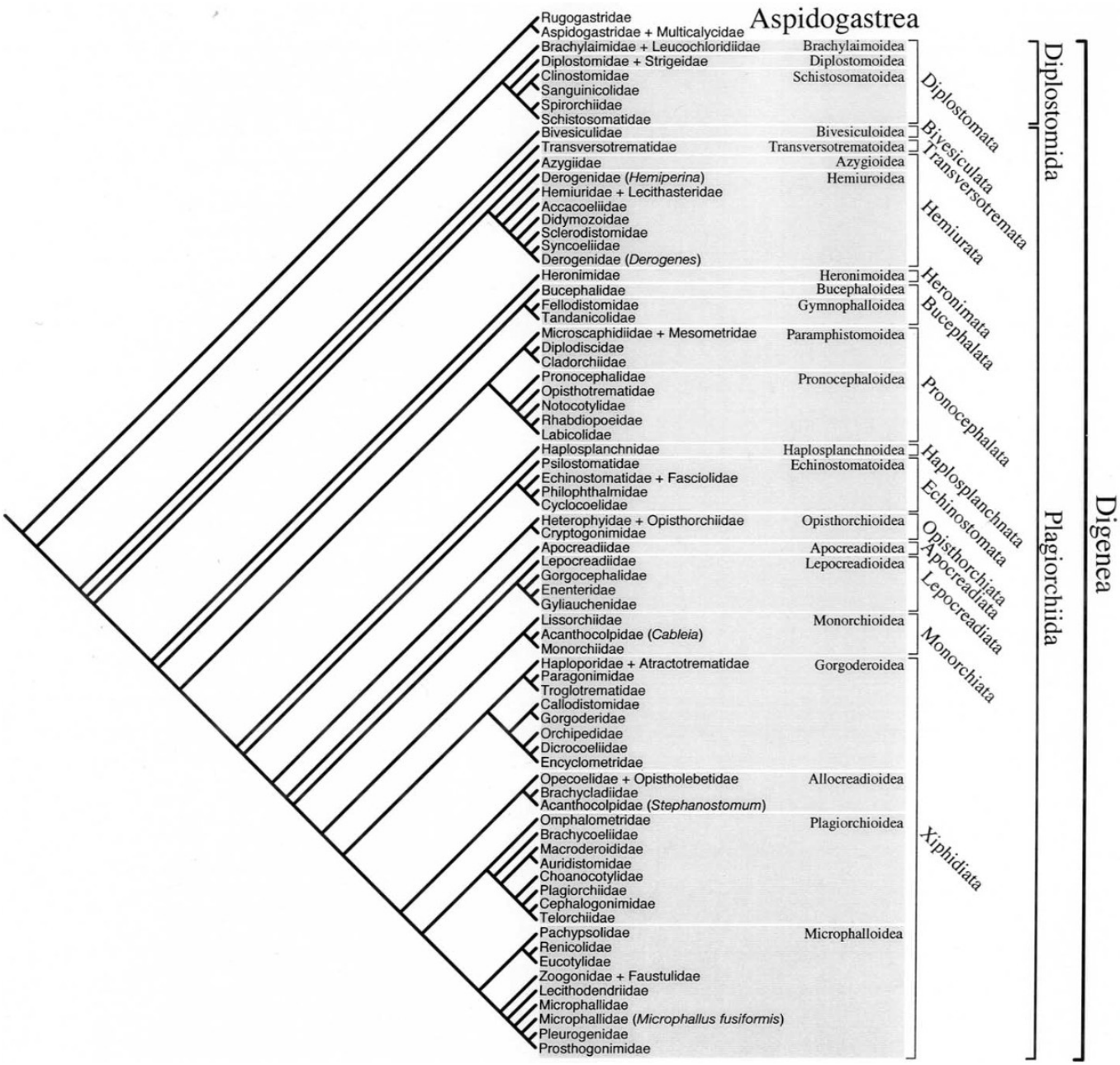
However, there is a note on the morphotype: we saw variation which do not correspond to any genetic variability, so we have learned that although morphotypes are a useful thing, it may look different.

It was surprising to learn that Imbricata cercariae are also members of genus Paramonostomum. We learned it when we found adults that are different from P. alveatum in several aspects: spines on the cirrus, thick cirrus sac; genital pore position. We identified them as P. anatis.

But it is not the same as the GenBank P. anatis. Either of the two is wrong, but which one?

Patterns in the phylogenetic trees.

Thank you for your attention.


Aspidogastrea
Rugogastridae
Aspidogastridae + Multicalycidae
Brachylaimidae + Leucochloridiidae
Diplostomidae + Strigeidae
Clinostomidae
Sanguinicolidae
Spirorchiidae
Schistosomatidae
Bivesiculidae
Transversotrematidae
Azygiidae
Derogenidae (Hemiperina)
Hemiuridae + Lecithasteridae
Accacoeliidae
Didymozoidae
Sclerodistomidae
Syncoeliidae
Derogenidae (Derogenes)
Heronimidae
Bucephalidae
Fellodistomidae
Tandanicolidae
Microscaphidiidae + Mesometridae
Diplodiscidae
Cladorchiidae
Pronocephalidae
Opisthotrematidae
Notocotylidae
Rhabdiopoeidae
Labicolidae
Haplosplanchnidae
Psilostomatidae
Echinostomatidae + Fasciolidae
Philophthalmidae
Cyclocoelidae
Heterophyidae + Opisthorchiidae
Cryptogonimidae
Apocreadiidae
Lepocreadiidae
Gorgocephalidae
Enenteridae
Gyliauchenidae
Lissorchiidae
Acanthocolpidae (Cableia)
Monorchiidae
Haploporidae + Atractotrematidae
Paragonimidae
Troglotrematidae
Callodistomidae
Gorgoderidae
Orchipedidae
Dicrocoeliidae
Encyclometridae
Opecoelidae + Opistholebetidae
Brachycladiidae
Acanthocolpidae (Stephanostomum)
Omphalometridae
Brachycoeliidae
Macroderoididae
Auridistomidae
Choanocotylidae
Plagiorchiidae
Cephalogonimidae
Telorchiidae
Pachypsolidae
Renicolidae
Eucotylidae
Zoogonidae + Faustulidae
Lecithodendriidae
Microphallidae
Microphallidae (Microphallus fusiformis)
Pleurogenidae
Prosthogonimidae
Brachylaimoidea
Diplostomoidea
Schistosomatoidea
Bivesiculoidea
Transversotrematoidea
Azygioidea
Hemiuroidea
Heronimoidea
Bucephaloidea
Gymnophalloidea
Paramphistomoidea
Pronocephaloidea
Haplosplanchnoidea
Echinostomatoidea
Opisthorchioidea
Apocreadioidea
Lepocreadioidea
Monorchioidea
Gorgoderoidea
Allocreadioidea
Plagiorchioidea
Microphalloidea
Diplostomata
Bivesiculata
Transversotremata
Hemiurata
Heronimata
Bucephalata
Pronocephalata
Haplosplanchnata
Echinostomata
Opisthorchiata
Apocreadiata
Lepocreadiata
Monorchiata
Xiphidiata
Diplostomida
Plagiorchiida
Digenea