

Larviculture

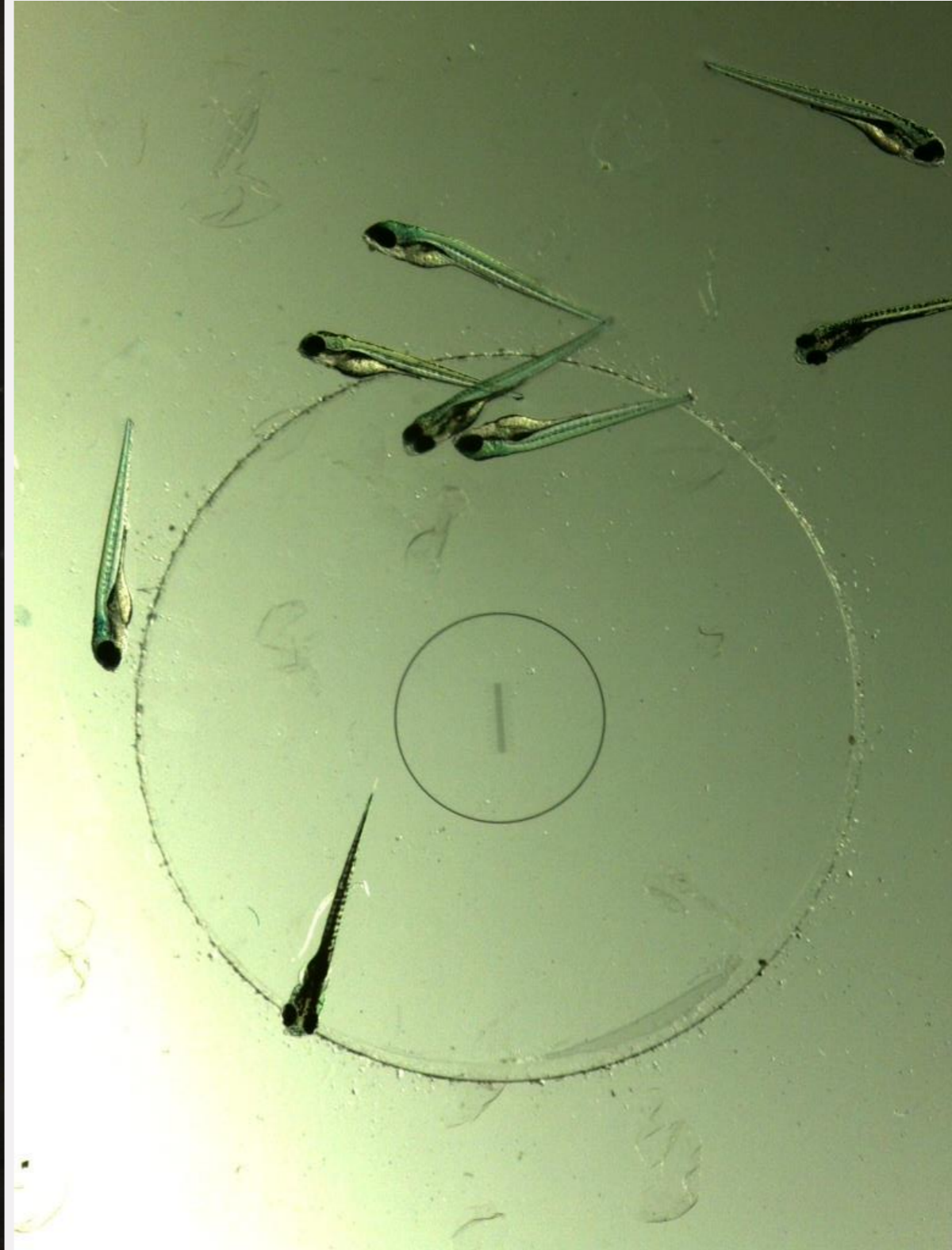
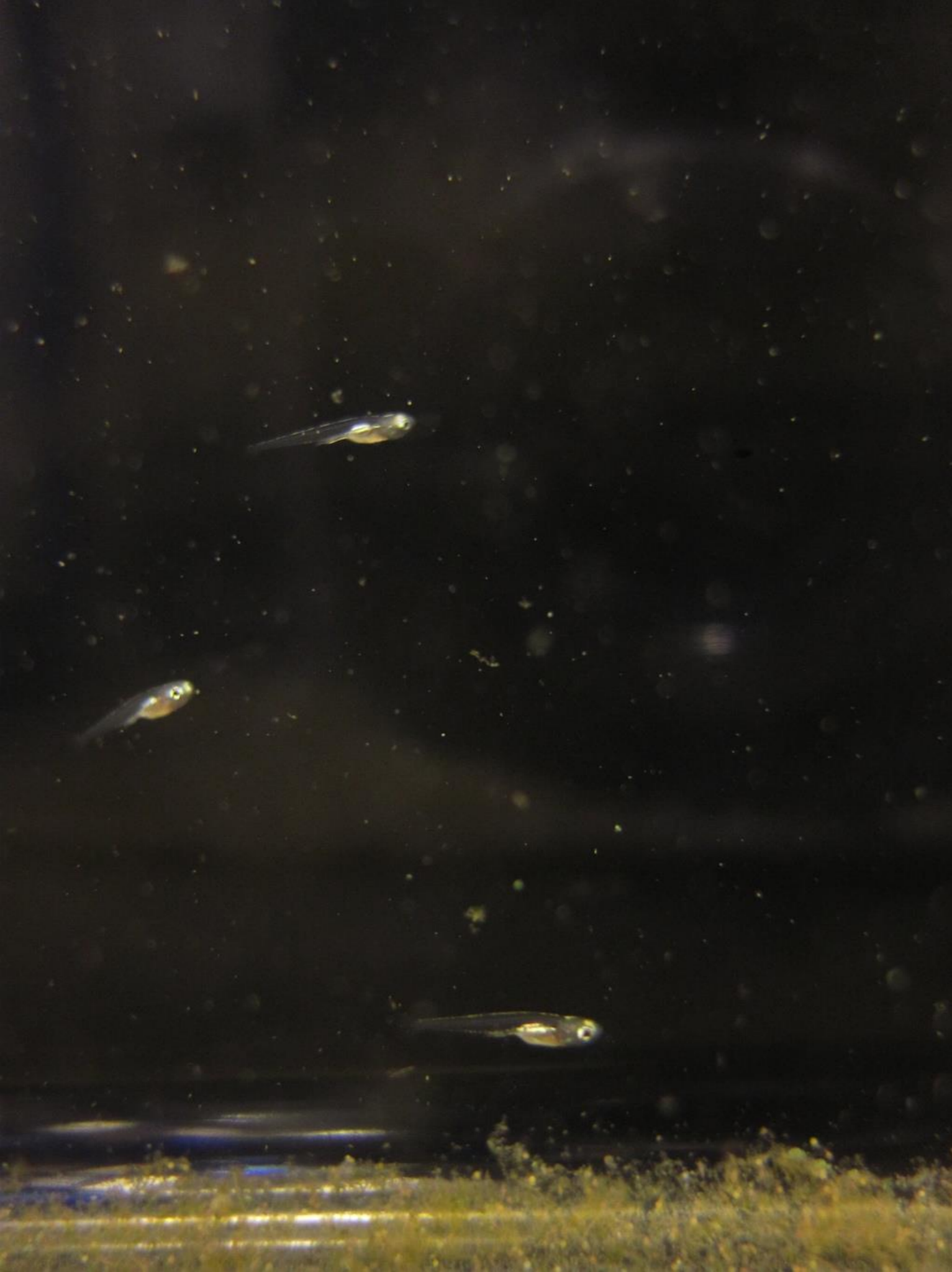
a critical look at a challenging task

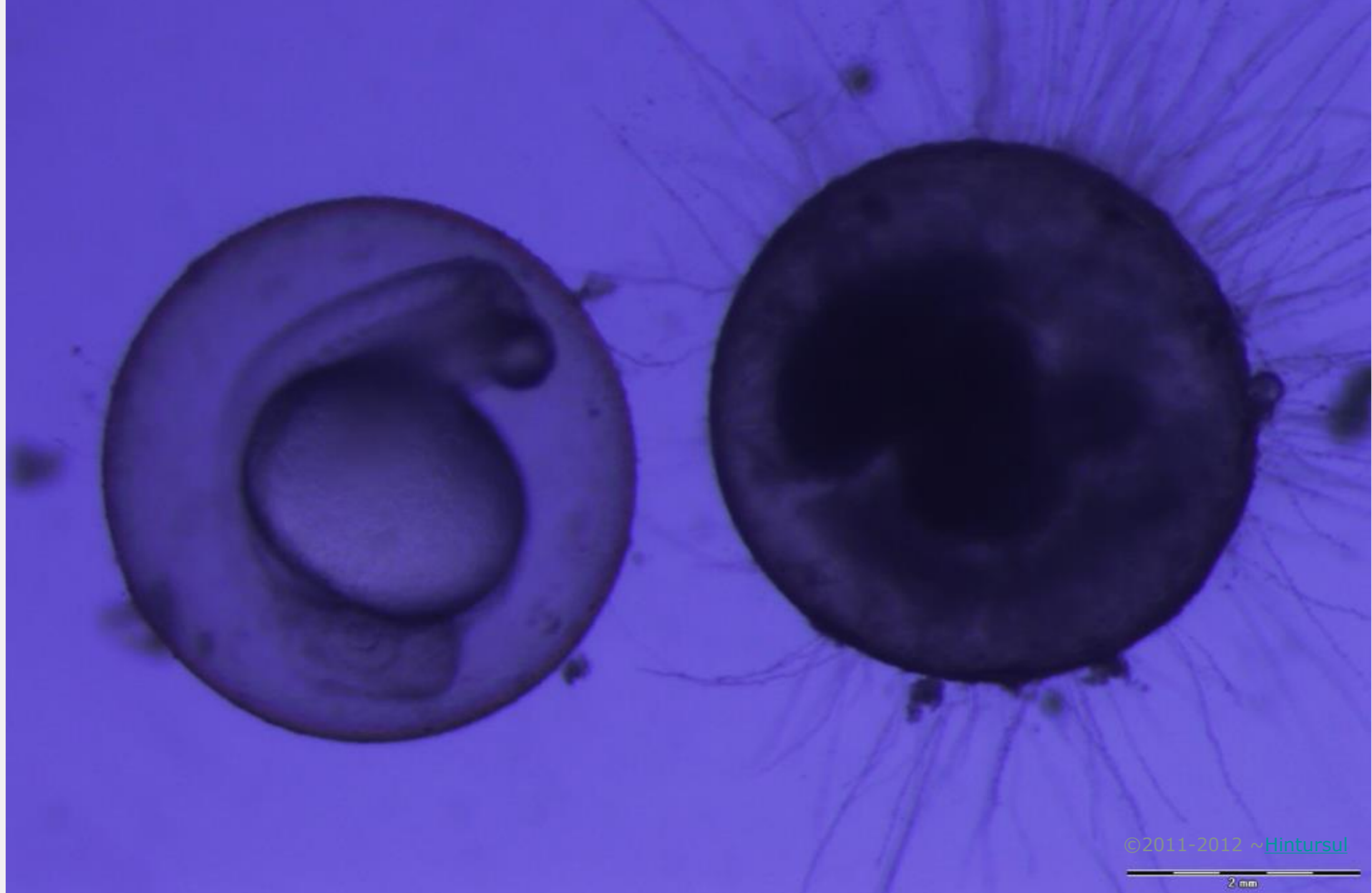


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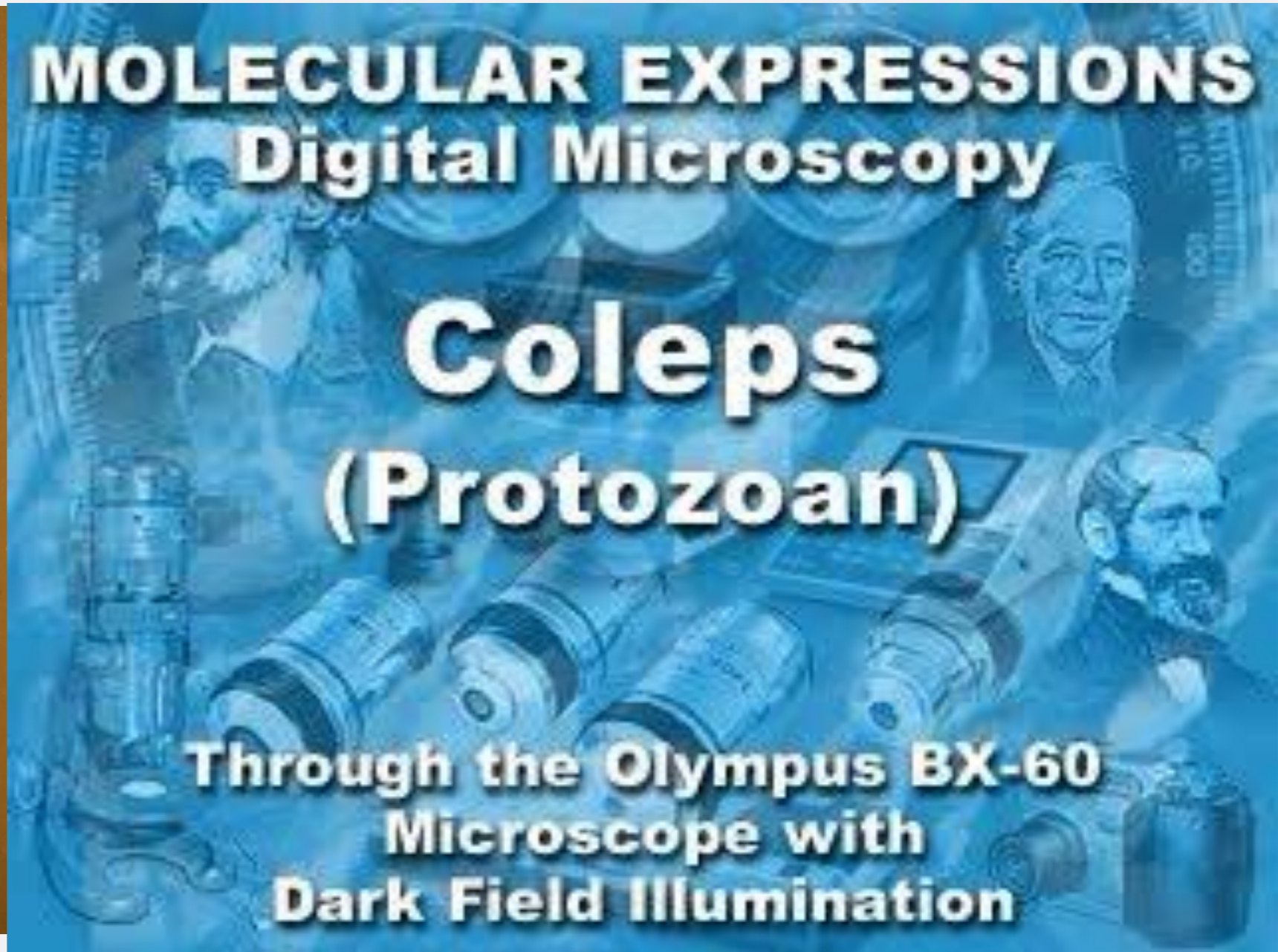
2014





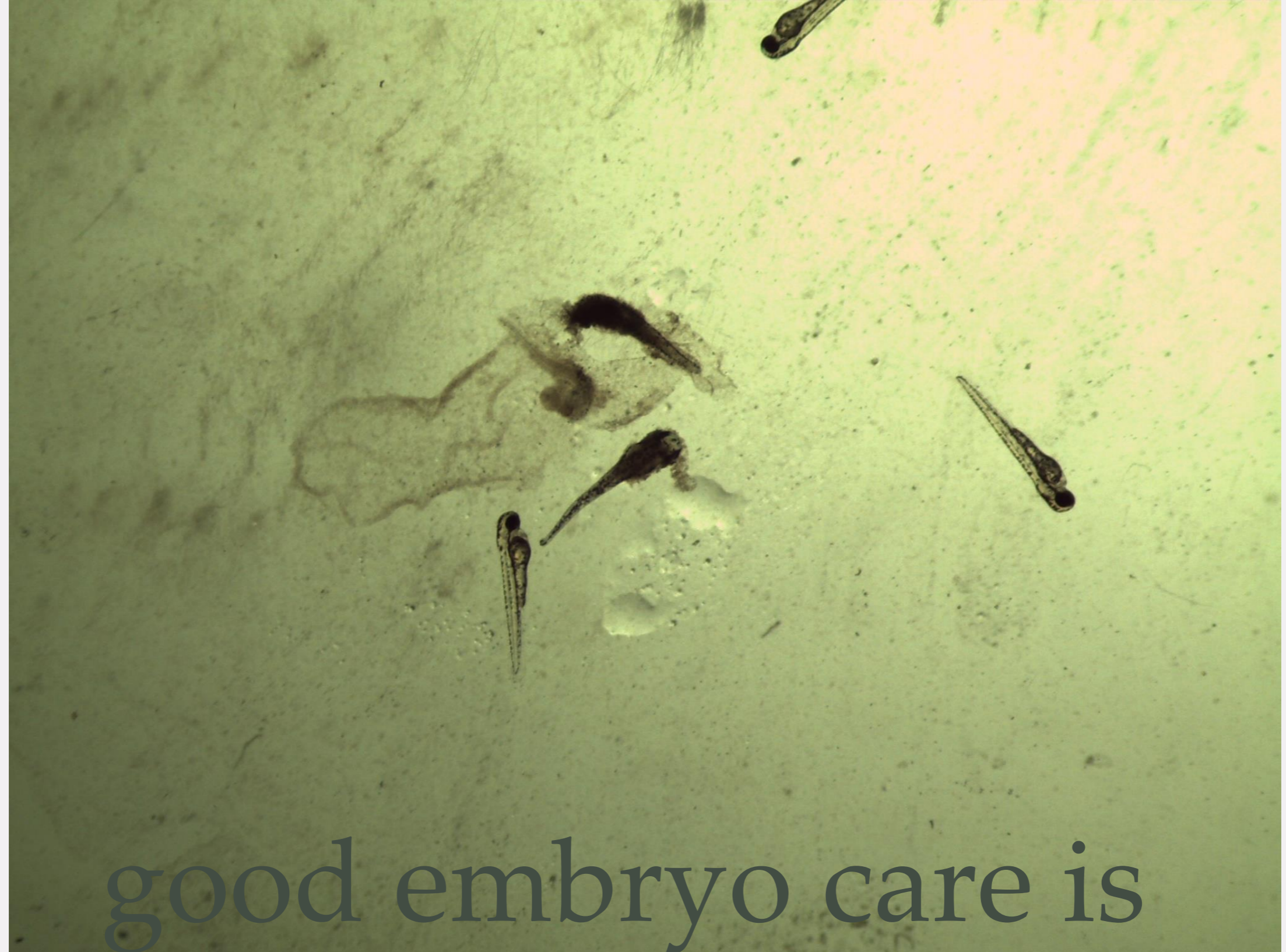
critical

*coleps, **fungi**, hypoxia, etc.*



good entry & care is
critical

coleps, fungi, hypoxia, etc.



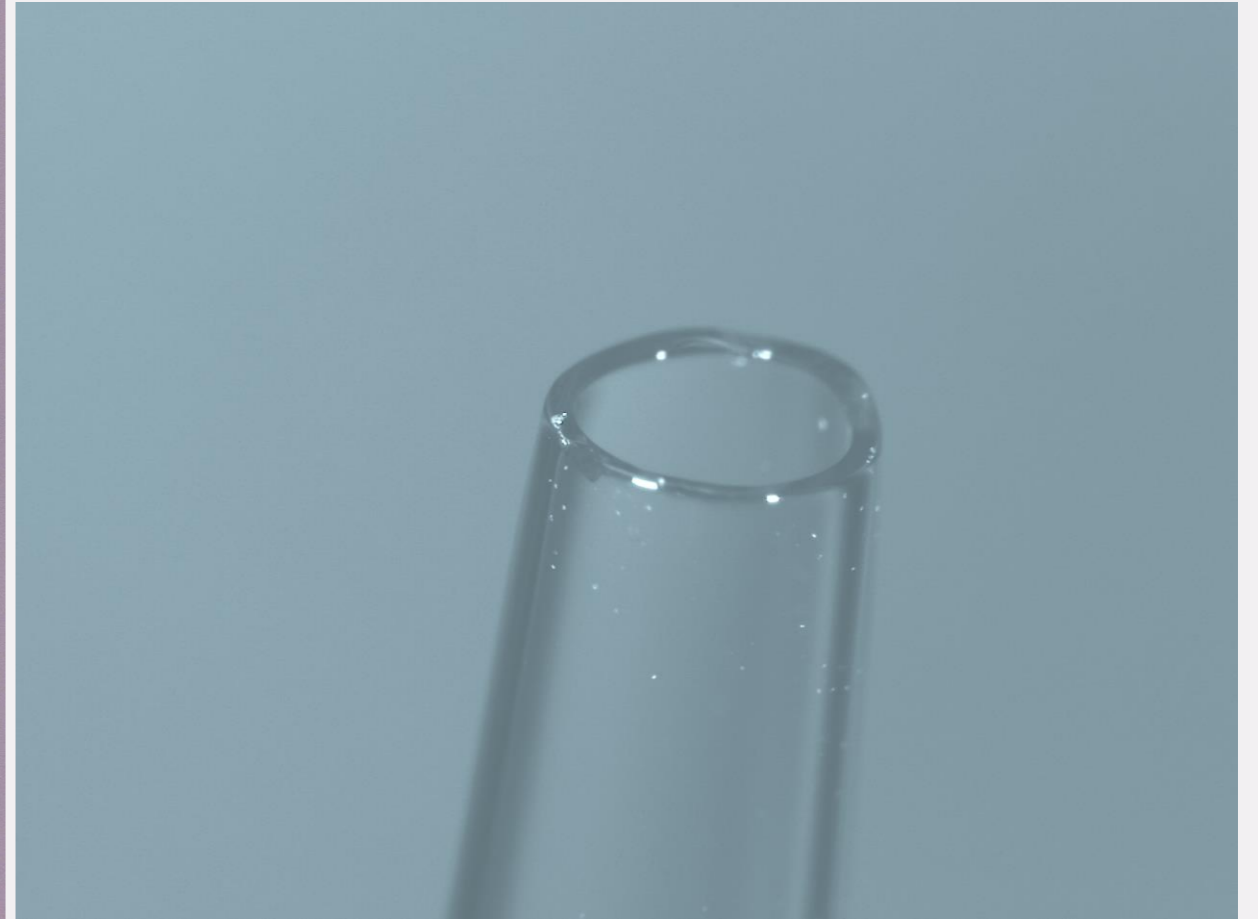
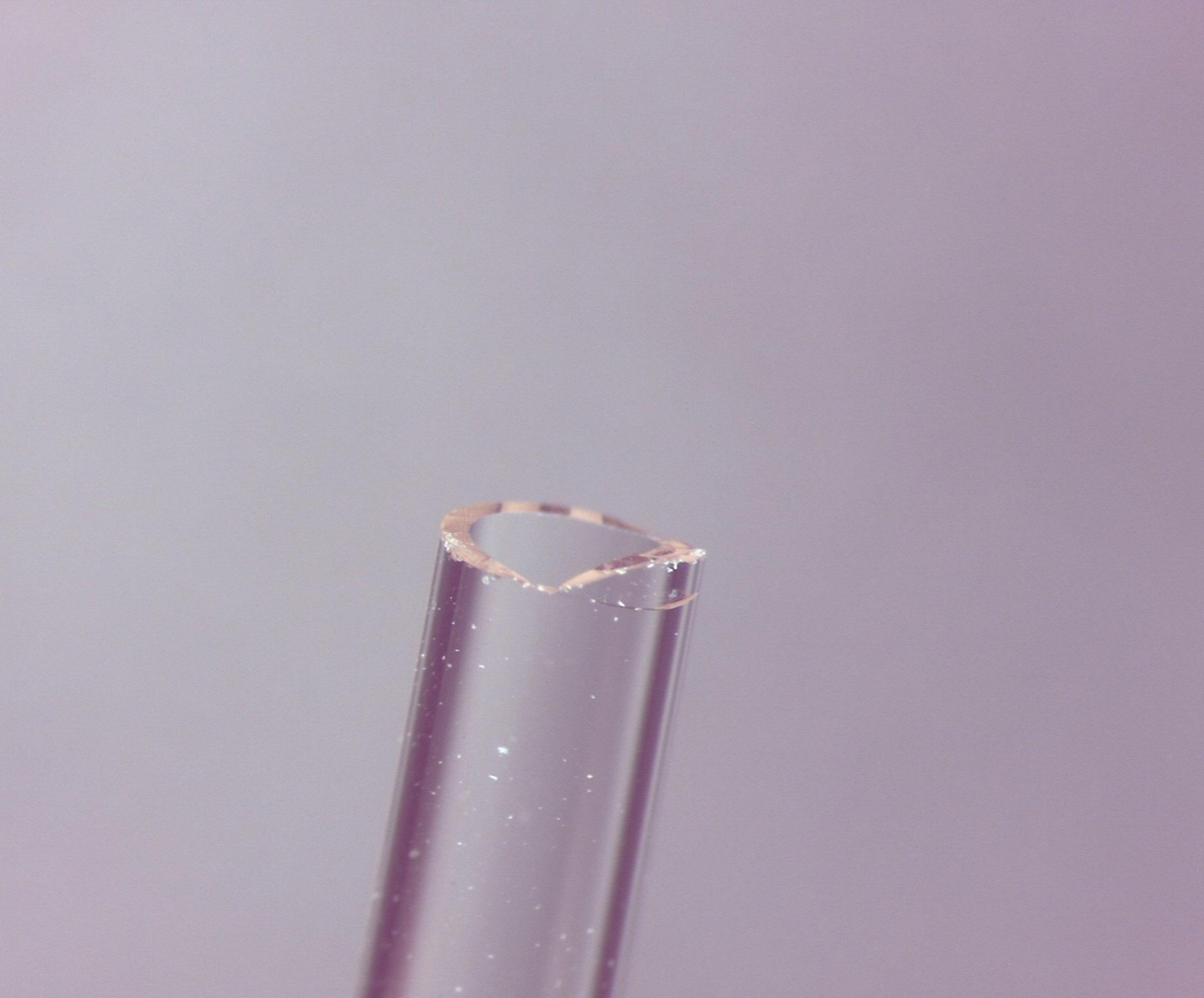
good embryo care is
critical

coleps, fungi, hypoxia, etc.



critical

coleps, fungi, hypoxia, etc.



good embryo care is critical
handling, cleanup, storage, density.

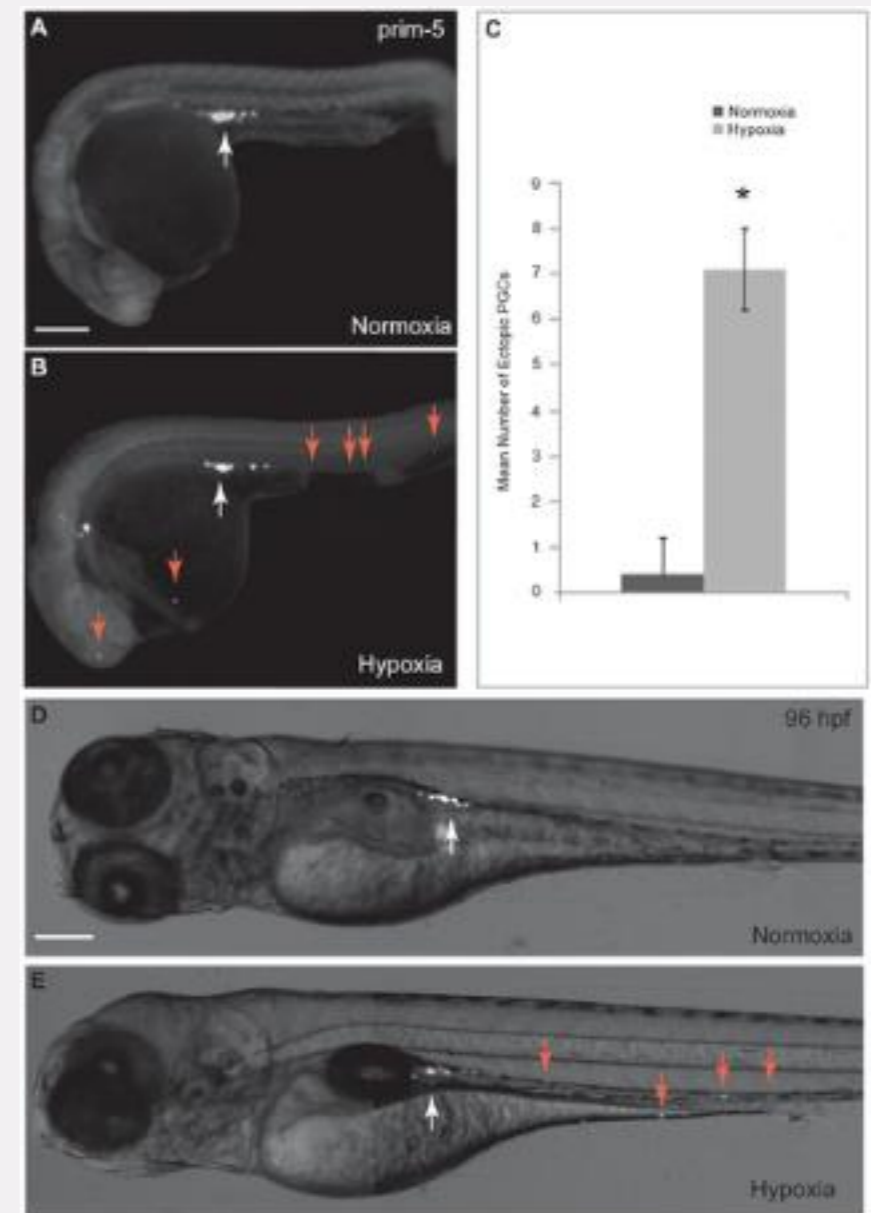
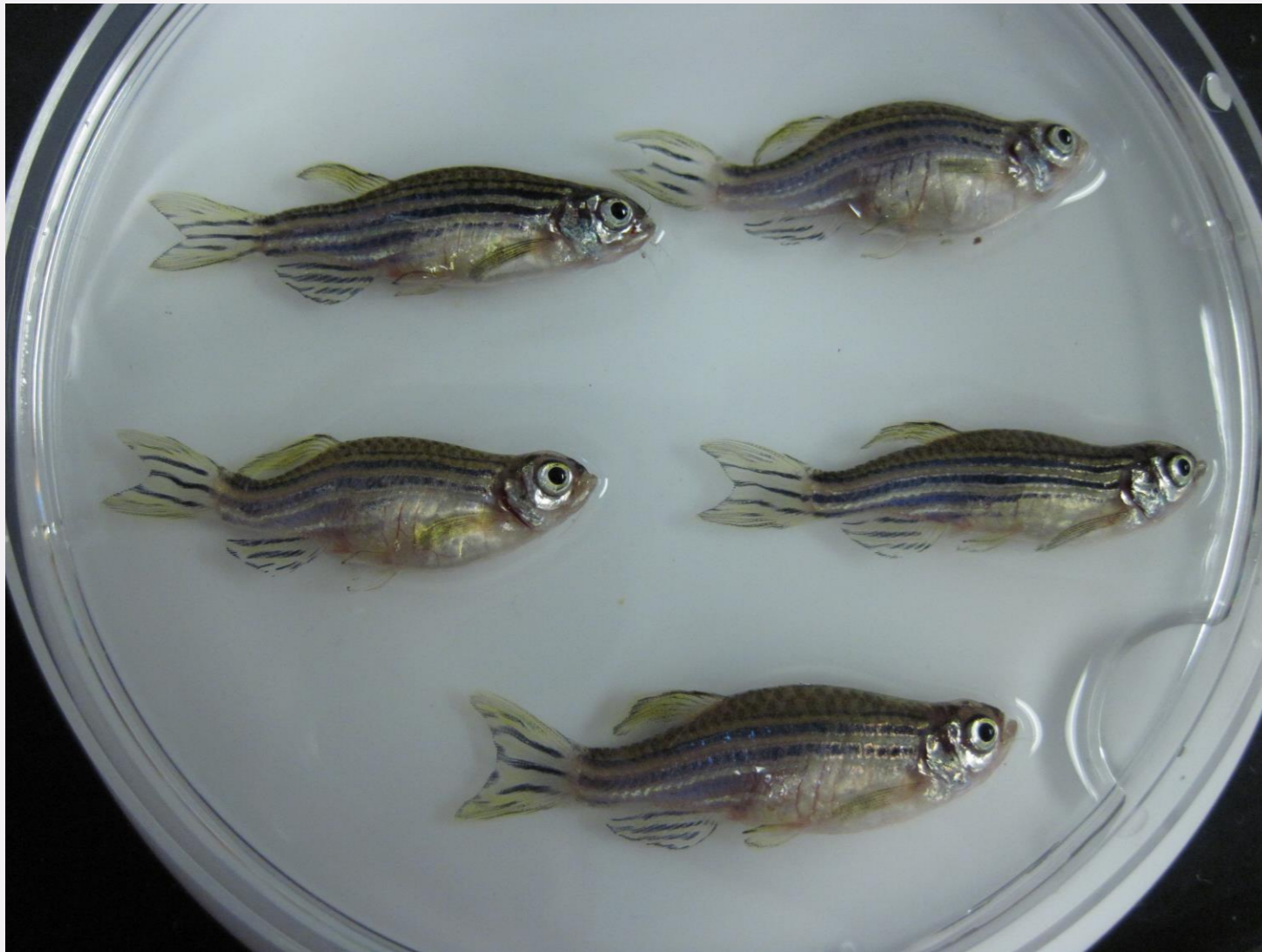
out of the box vs. fire-polished

Pasteur transfer pipet



good embryo care is critical
handling, cleanup, storage, density.

out of the box vs. fire-polished



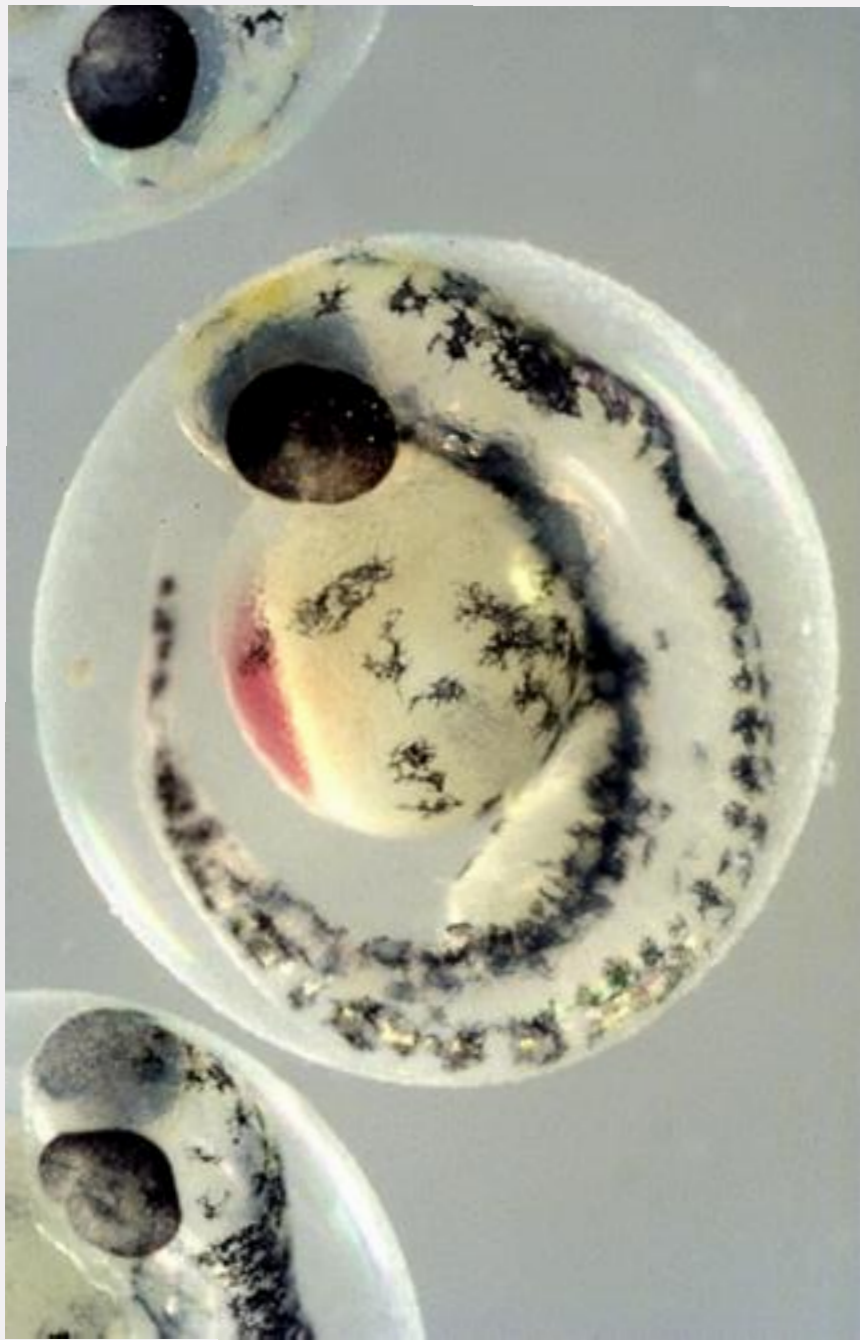
good embryo care is critical
coleps, fungi, hypoxia, etc.

Effects of hypoxia are wide-ranging. From developmental retardation and abnormalities to primordial germ cell migration defects, and disruption of pathfinding of forebrain neurons. more than 10K hits on Google scholar “zebrafish hypoxia”

Hatching (48 - 72 h)	Long-pec	48 h	EL = 3.1 mm; elongated pectoral fin buds
	Pec-fin	60 h	EL = 3.3 mm; pectoral fin blades
Larval	Protruding-mouth	72 h	3.5 mm total body length
	Day 4	96 h	3.7 mm total body length
	Day 5	120 h	3.9 mm total body length; 6 teeth
	Day 6	144 h	4.2 mm total body length
	Days 7-13	168 h	4.5 mm total body length; 8 teeth
	Days 14-20	14 d	6.2 mm total body length; 10 teeth
	Days 21-29	21 d	7.8 mm total body length
Juvenile	Days 30-44	30 d	10 mm total body length; adult fins/pigment
	Days 45-89	45 d	14 mm total body length; 12 teeth
Adult (90 d - 2 y)		90 d	Breeding adult

clear definitions?

according to Zfin

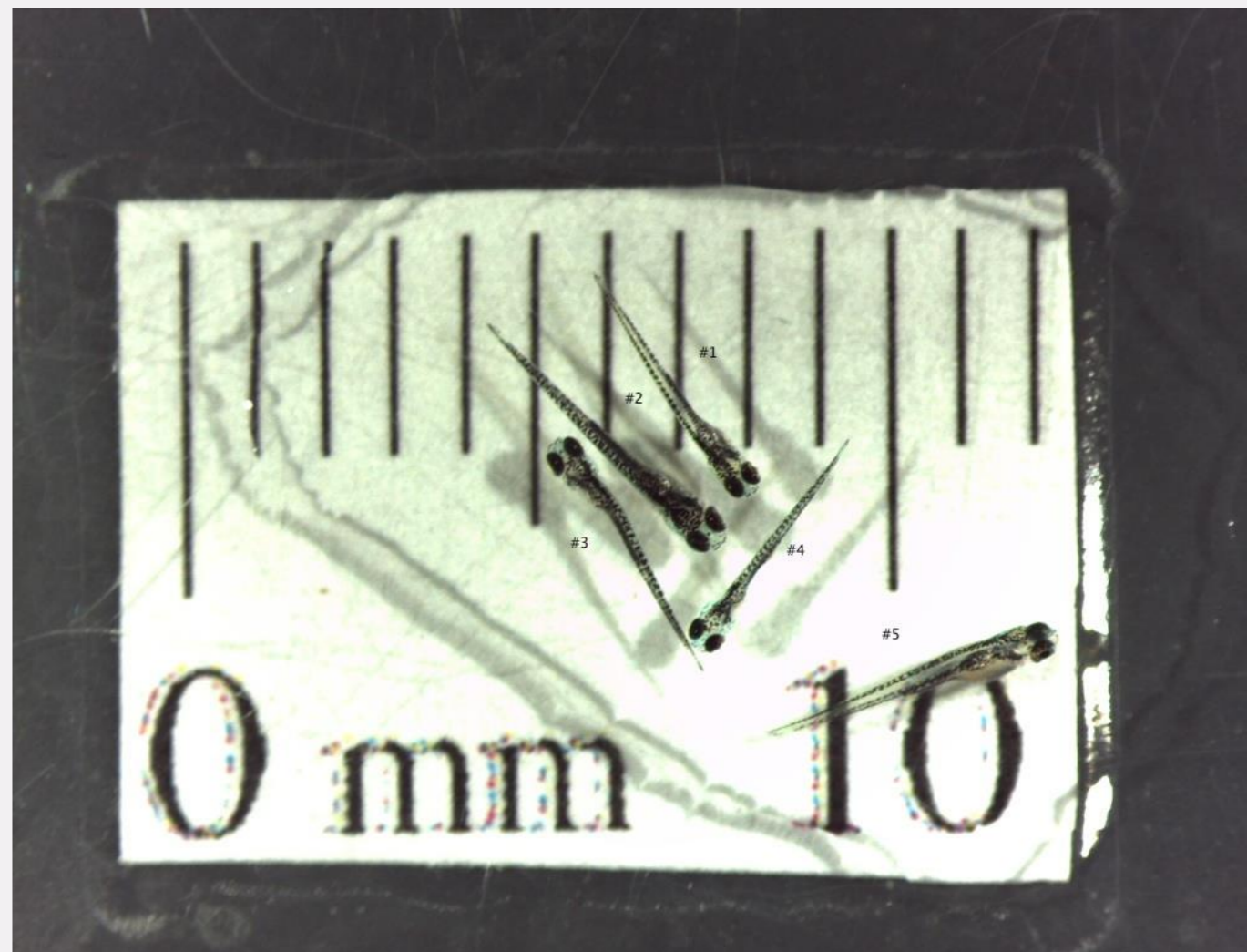
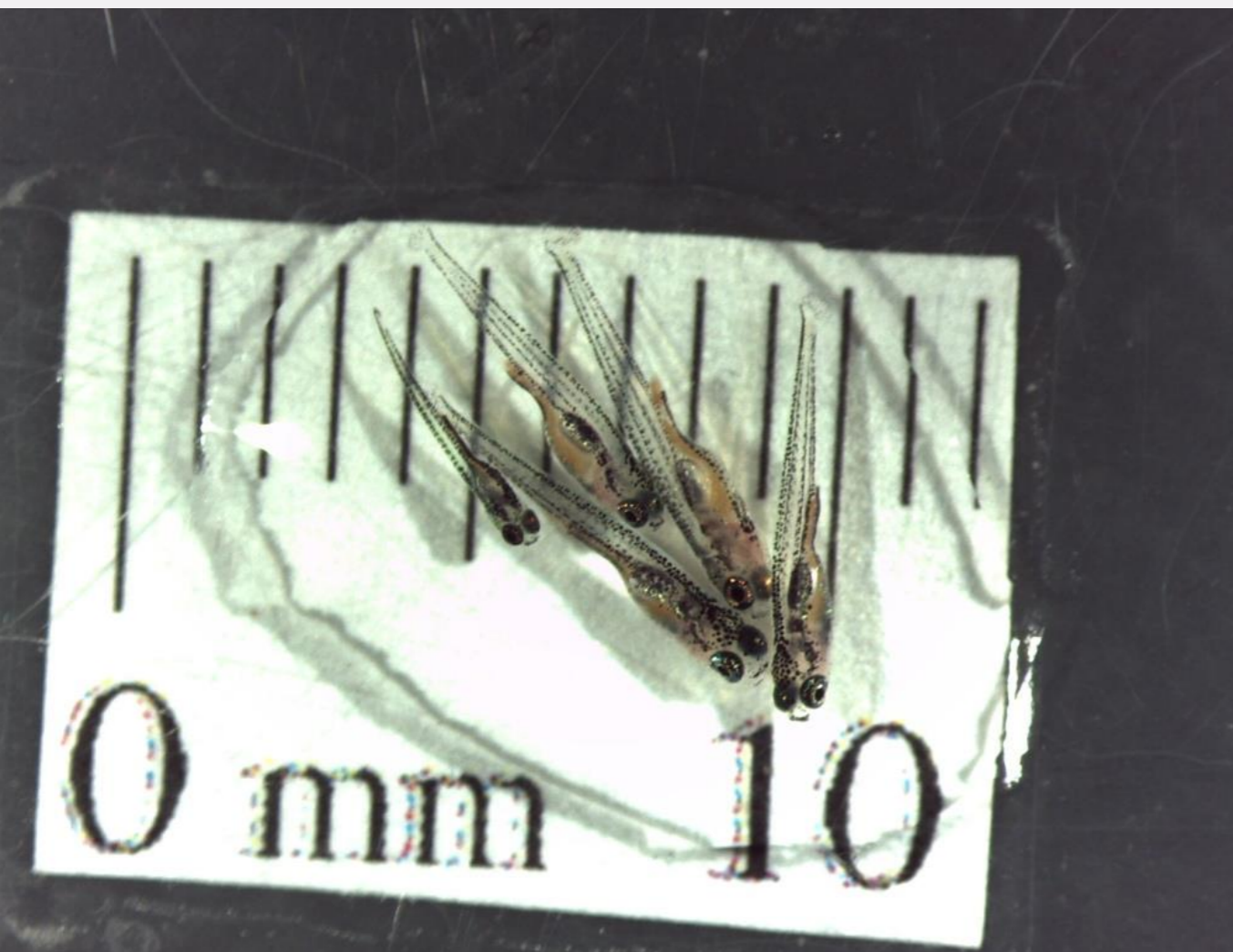


clear definitions

embryo & larvae



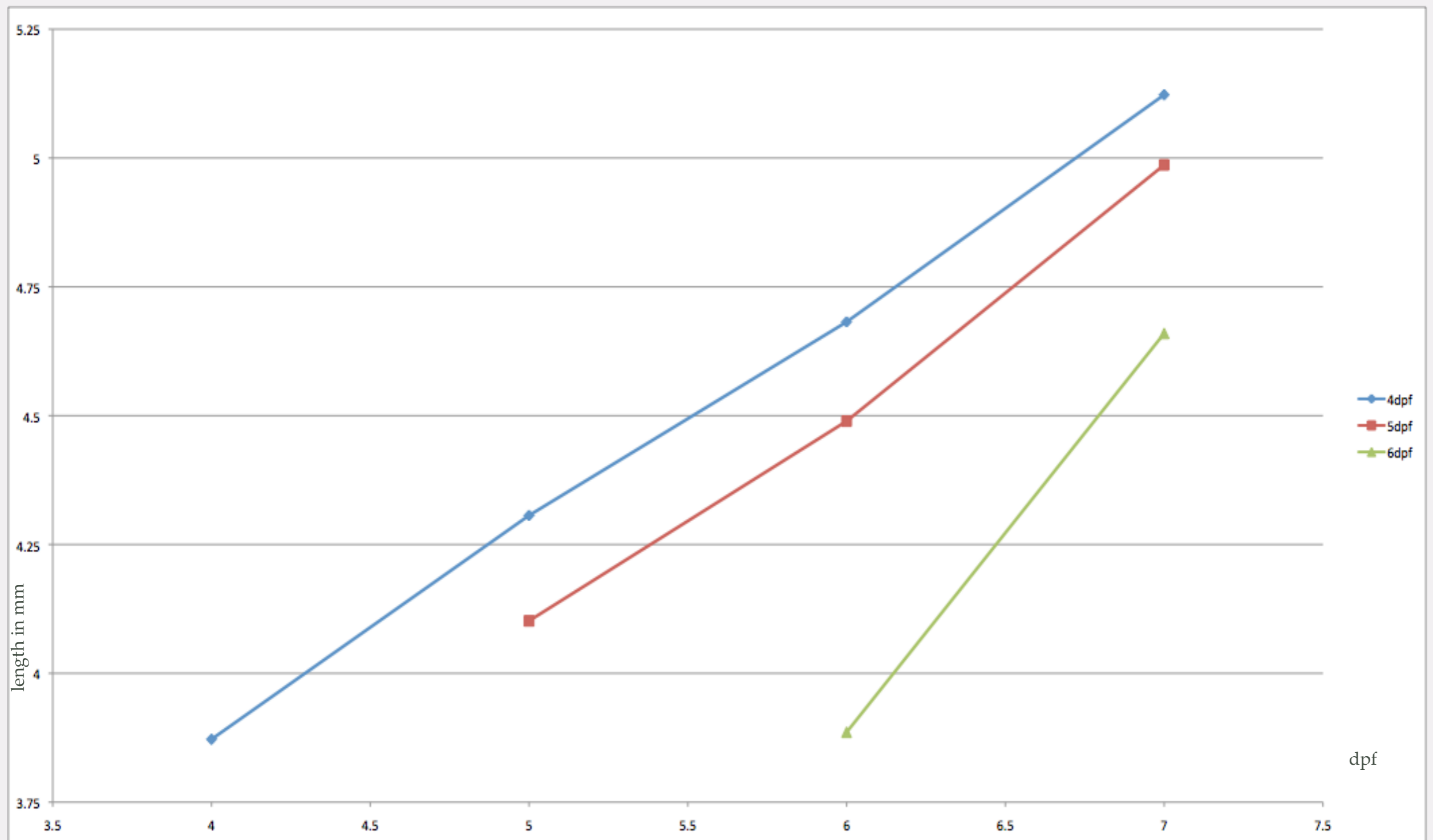
Too early
and too much water



Waiting too long can be disastrous

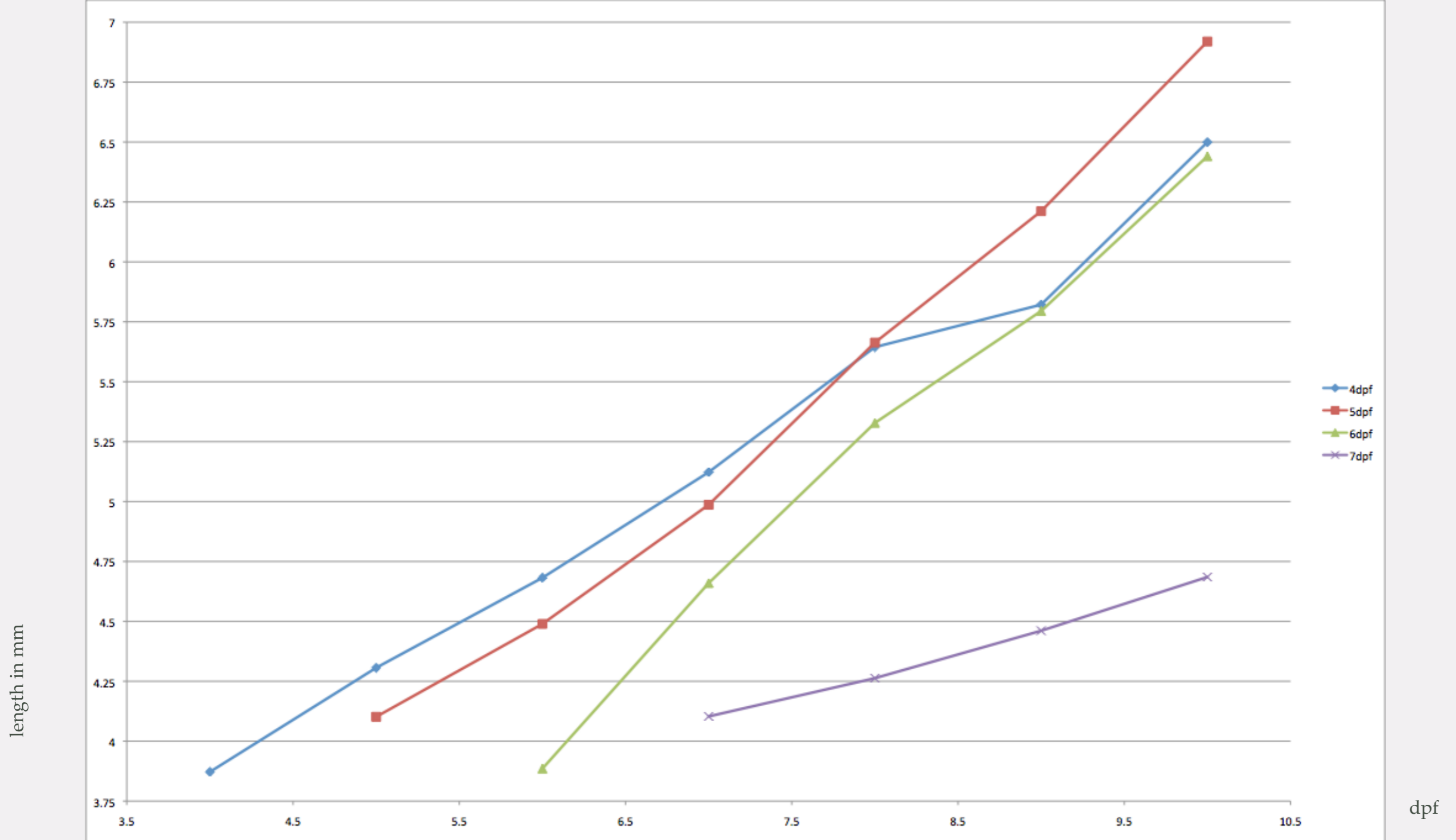
both are 10dpf and same clutch

the left, offered food at 4pdf; on the right offered food at 7dpf



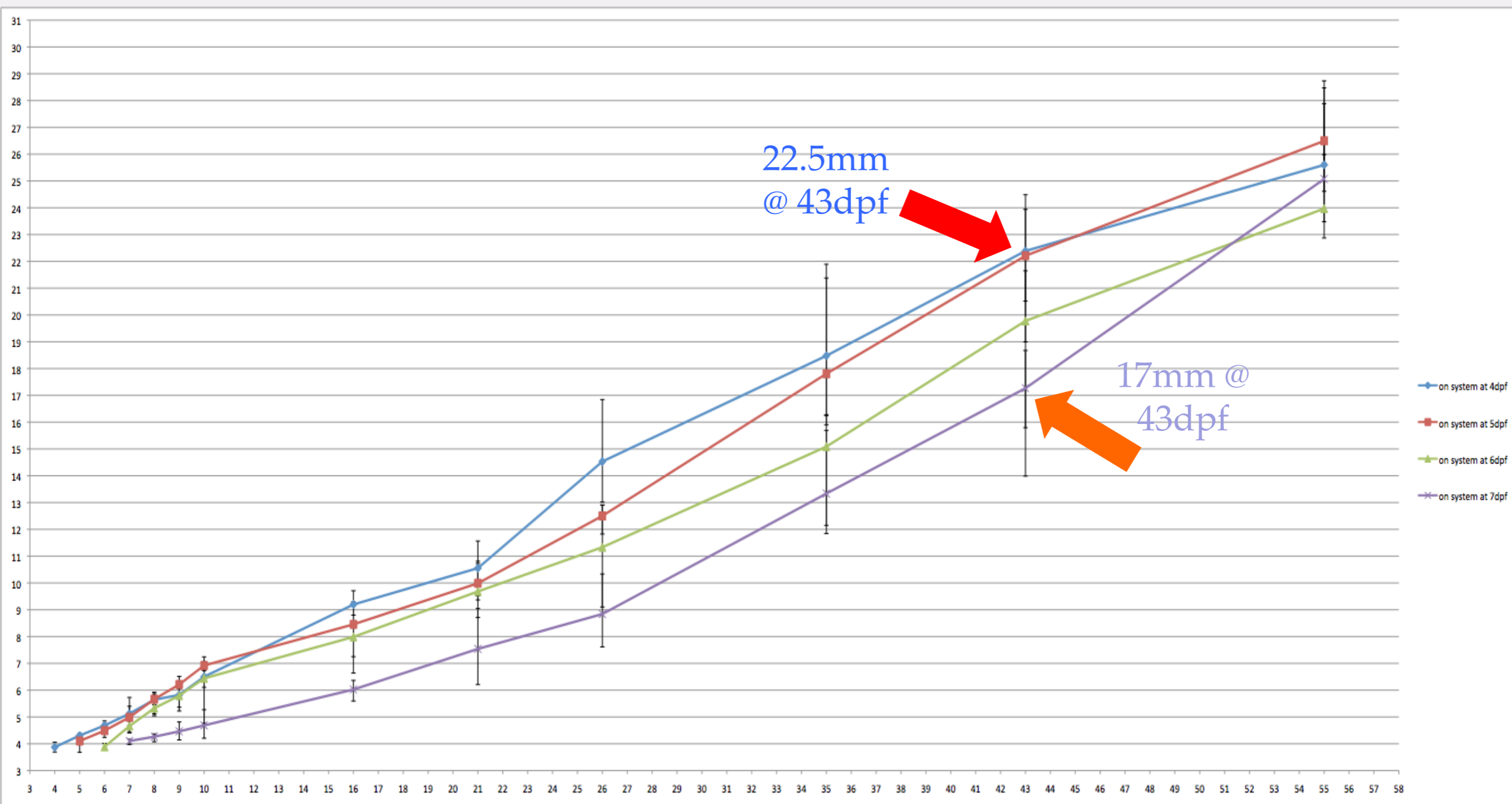
When to start feeding

time isn't the best or absolute answer



When to start feeding

time isn't the best or absolute answer



When to start feeding

time isn't the best or absolute answer



first-feeding methods and options

(a need for a clearer understanding of what the conditions in the tank are and what they mean for fish survival and growth)

Not All Algae are = (or even real algae)

**5-10g/L of system water*

**(?ammonia binder?)*

**~50mL/tank (3.5L)*

**3X/day*

**slow-med pace drip*

**make it DARK!*

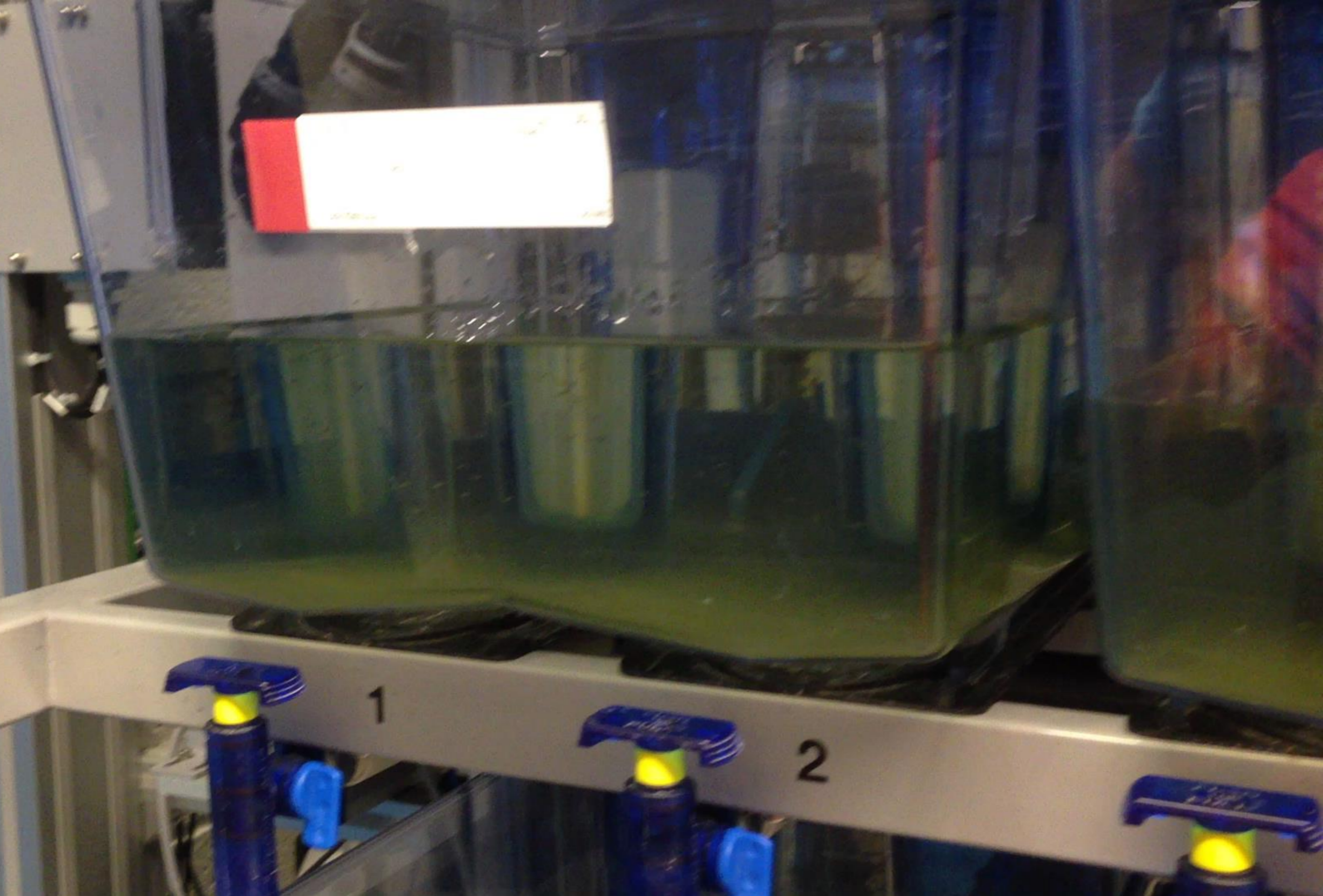
Green-water technique



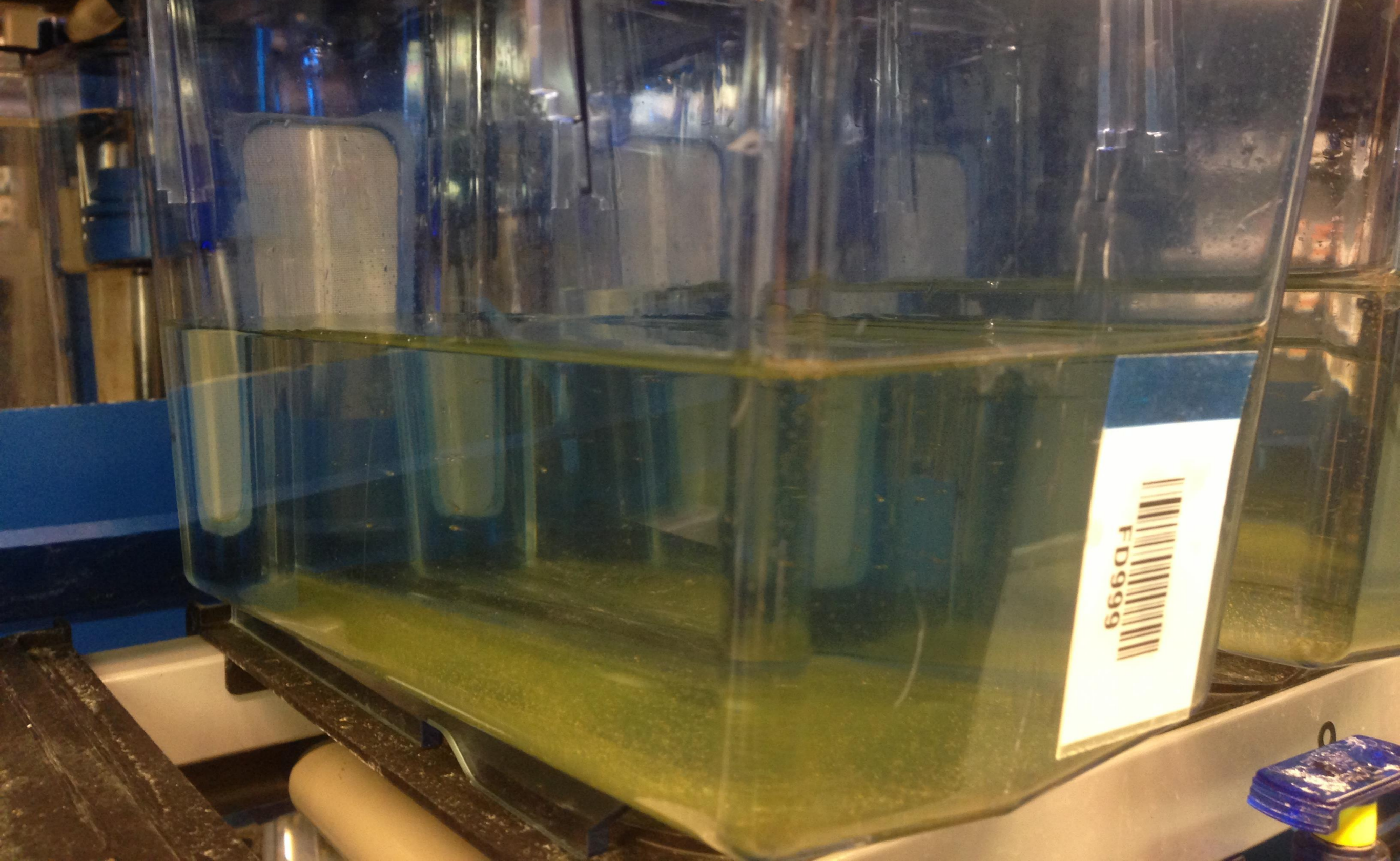
larval fish feeding on rotifers

larval fish
feeding on
rotifers





larval fish tanks with rotifers



larval fish tanks with rotifers



larval fish tanks with rotifers



larval fish tanks with rotifers



larval fish tanks with rotifers

# of tanks (3.5L) to feed rotifers to	# of L needed for feedout (30mL/tank)	# rotifers (M) needed for feedout
300	9	31.5
275	8.25	28.875
250	7.5	26.25
225	6.75	23.625
200	6	21
190	5.7	19.95
180	5.4	18.9
170	5.1	17.85
160	4.8	16.8
150	4.5	15.75
140	4.2	14.7
130	3.9	13.65
120	3.6	12.6
110	3.3	11.55
100	3	10.5
90	2.7	9.45
80	2.4	8.4
70	2.1	7.35
60	1.8	6.3
50	1.5	5.25
40	1.2	4.2
30	0.9	3.15
20	0.6	2.1
10	0.3	1.05

~30000/tank/day

~1000/fish

How much (many) rotifers?

This is my “ideal” situation. Less will work fine.

If it smells bad.....

If it looks milky/hazy/cloudy...

If there is a scum or a slick.....

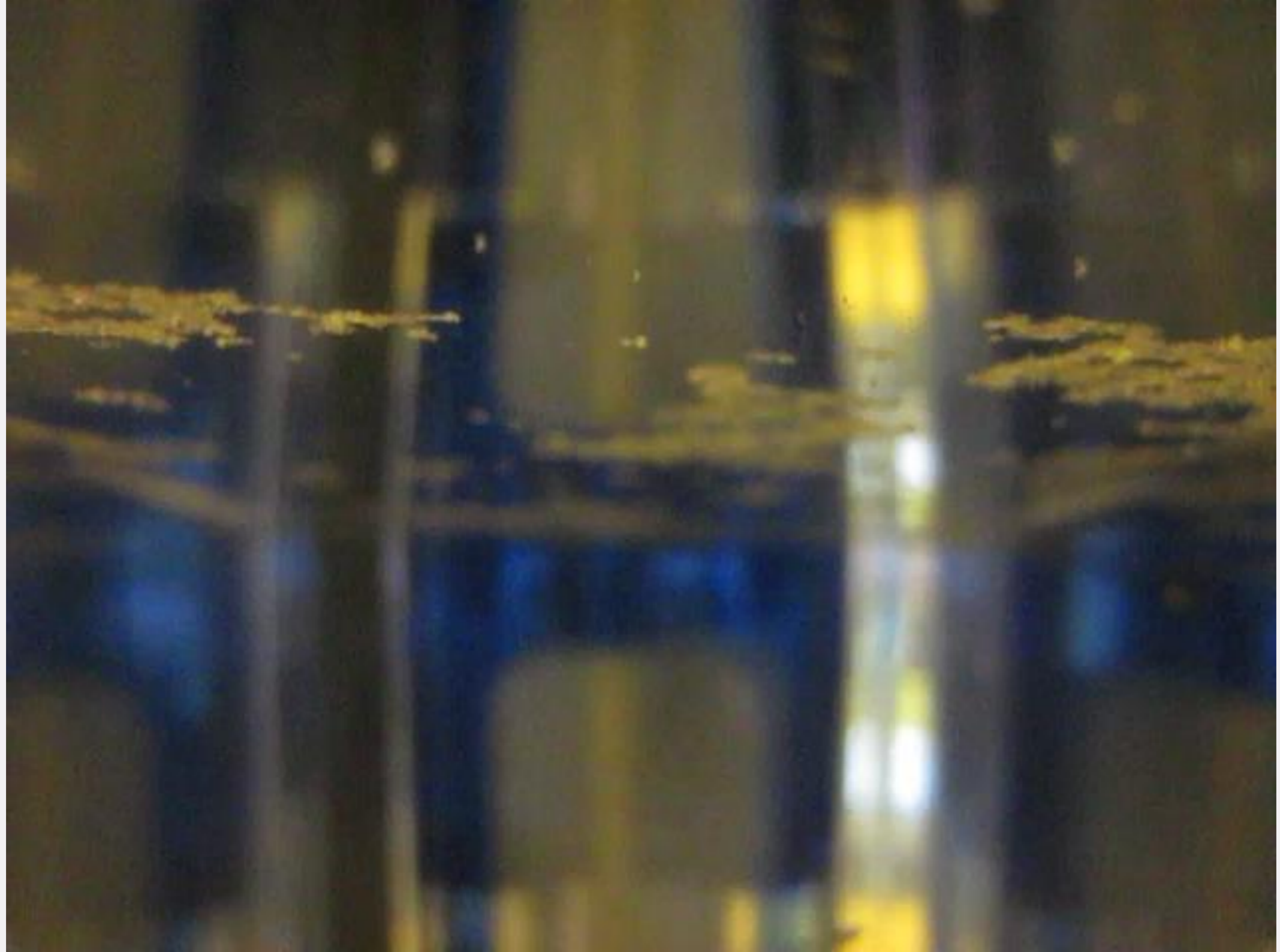
These conditions require an ACTION from you
What actions do you take?

Trust your senses and your intuition

use your nose and your eyes!



rotifer fed larvae stressed due to
scum on water

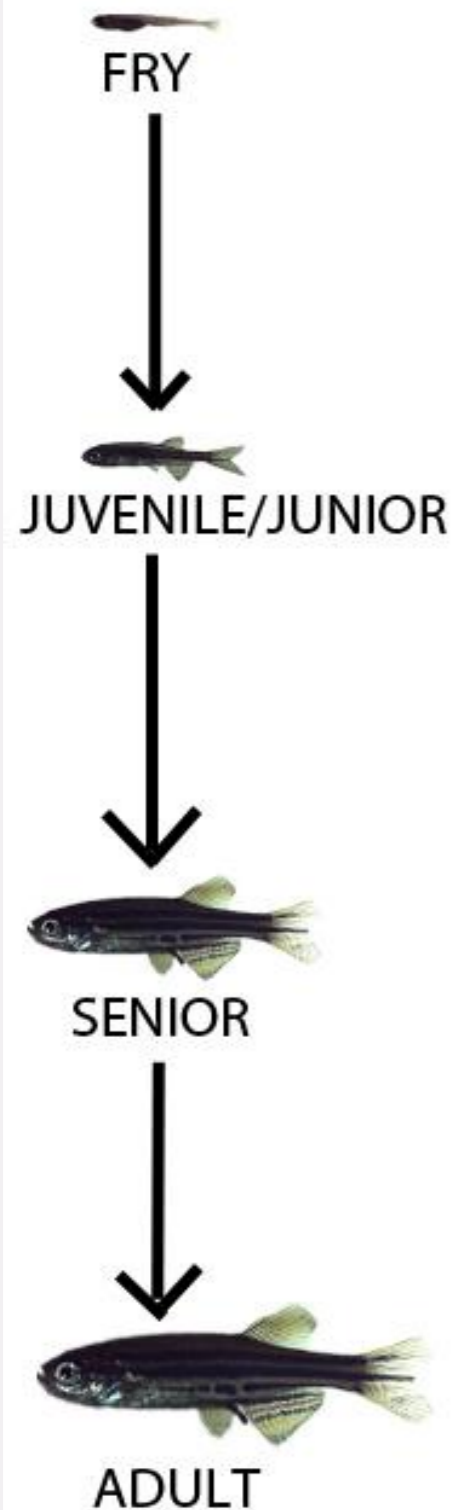


difference in water surface between
slow-stream to rapid drip



Let them eat...

your observations are the basis for diet changes



graphic tools

empower the staff and researchers to make decisions and avoid making mistakes

zoo/phyto-
plankton?



post-metamorphic feed choices

live and prepared (greenwater)

live diets

artemia

rotifers

daphnia? copepods? other plankton?

prepared diets

aquaculture feeds vs. hobbyist feeds

differing protein sources and bio-availability

fatty acid profiles tuned to warm vs. coldwater fish

carotenoids (antioxidants)

differing bouyancies (dispersal differences)

post-metamorphic feed choices

live, and prepared

How to apply?

top fed (dry)

distribution problems

aggression

runting (competition related)

mouth (cranio-facial deformities)

Liquified

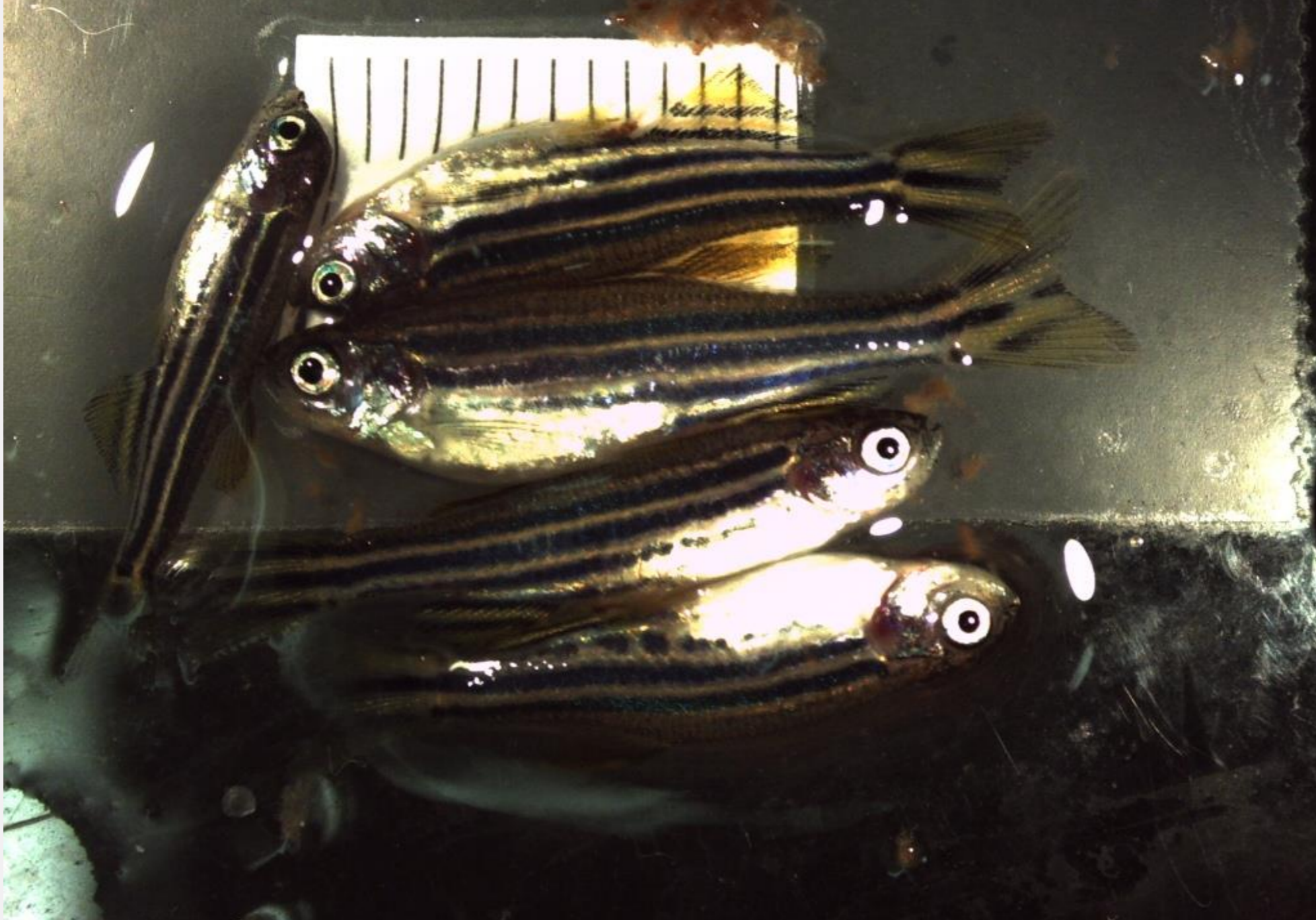
how to homogenize

how to quantify and distribute- metered dose?

shelf life- none.

post-metamorphic feeds

prepared diets



32dpf

clear definitions?

juvenile & adult



measured from snout to caudal peduncle

40-dpf

~28mm

40dpf

Juvenile?

metamorphosis to sexual di-morphism/maturity



adult fish feeding on rotifers

Feeding Frequencies

larvae

constant

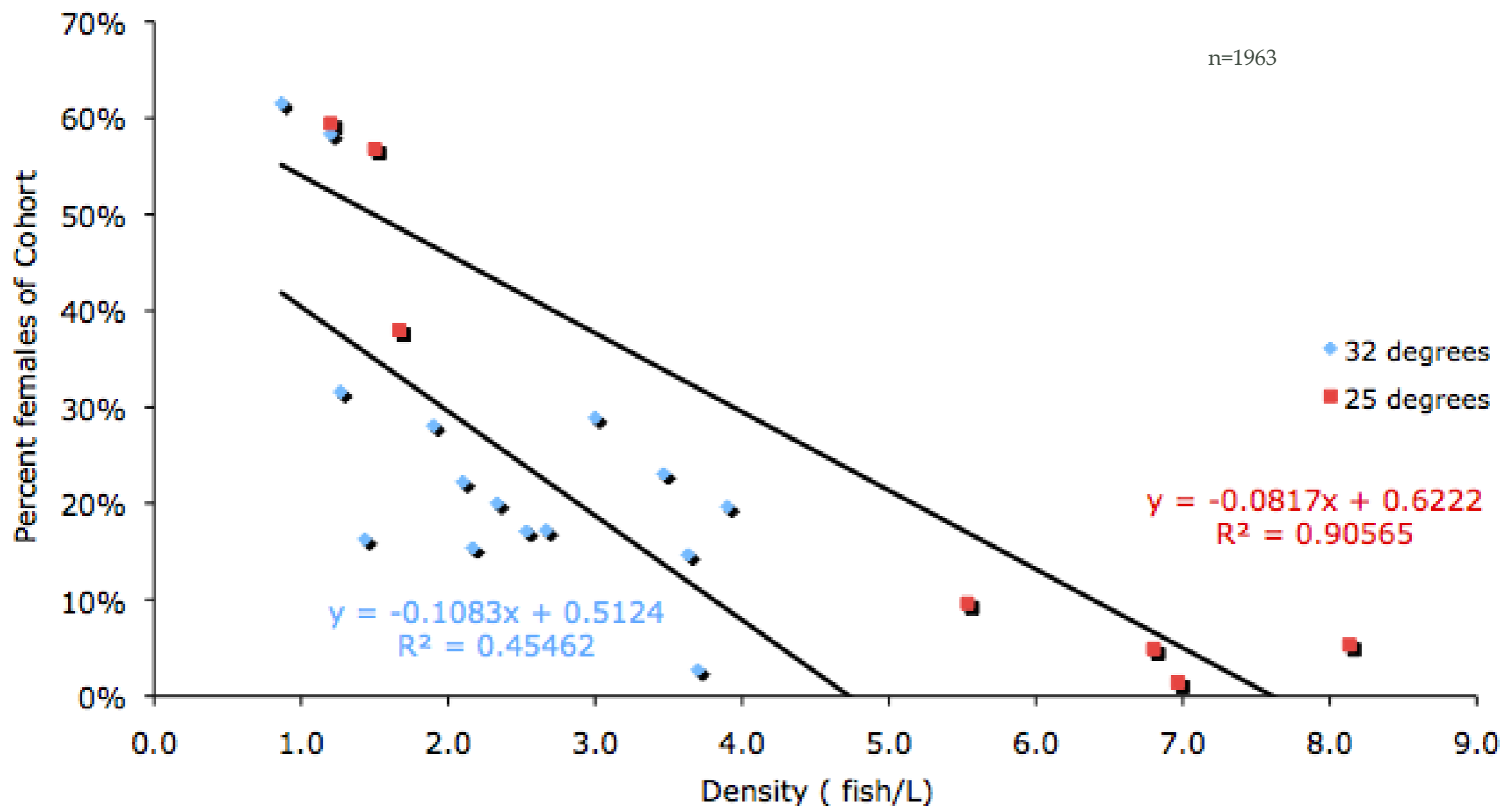
juvenile

high frequency

sub-adult

high frequency

percent females vs. density



downstream effects of stocking choices

temperature and density (larvae/L)

	stock#	fert. Date	25C	32C	female QTY	male QTY	Nursery fish/L	males per female	percent females
	11162	19-Jun-09		X	23	94	3.9	4.1	19.66%
	11162	19-Jun-09		X	24	80	3.5	3.3	23.08%
	11162	19-Jun-09		X	16	93	3.6	5.8	14.68%
	11162	19-Jun-09		X	8	72	2.7	9.0	10.00%
	11162	19-Jun-09		X	16	66	2.7	4.1	19.51%
	11162	19-Jun-09		*	12	62	2.5	5.2	16.22%
	11162	19-Jun-09		*	23	60	2.8	2.6	27.71%
low temp, low density	11230	24-Jun-09	X		25	19	1.5	0.8	56.82%
low temp, low density	11230	24-Jun-09	X		19	31	1.7	1.6	38.00%
	11162	19-Jun-09		X	13	63	2.5	4.8	17.11%
high temp, low density	11162	19-Jun-09		X	12	26	1.3	2.2	31.58%
	11162	19-Jun-09		X	26	64	3.0	2.5	28.89%
	11162	19-Jun-09		X	22	60	2.7	2.7	26.83%
high temp, high density	11162	19-Jun-09		X	3	108	3.7	36.0	2.70%
	11230	24-Jun-09	X		16	150	5.5	9.4	9.64%
	11230	24-Jun-09	X		13	231	8.1	17.8	5.33%
low temp, high density	11230	24-Jun-09	X		3	206	7.0	68.7	1.44%
	11230	24-Jun-09	X		10	194	6.8	19.4	4.90%
					n =	1963			
	X= raised at this temperature from 0dpf to adulthood								
	*= 0-6dpf at 32C, 6dpf-19dpf at 25C, 19dpf to adulthood at 32C								

downstream effects of stocking choices

temperature and density (larvae/L)

???

When are they ready to
breed?

QTY of Tanks	Feedout Artemia needed (L)	total (g) decap	amount of culture water (4.5ppt)	QTY of Tanks	Feedout Artemia needed (L)	total (g) decap	amount of culture water (4.5ppt)	QTY of Tanks	Feedout Artemia needed (L)	total (g) decap	amount of culture water (4.5ppt)
200	1	13.5	3	3600	18	243.0	61	7100	35.5	479.3	120
300	1.5	20.3	5	3700	18.5	249.8	62	7200	36	486.0	122
400	2	27.0	7	3800	19	256.5	64	7300	36.5	492.8	123
500	2.5	33.8	8	3900	19.5	263.3	66	7400	37	499.5	125
600	3	40.5	10	4000	20	270.0	68	7500	37.5	506.3	127
700	3.5	47.3	12	4100	20.5	276.8	69	7600	38	513.0	128
800	4	54.0	14	4200	21	283.5	71	7700	38.5	519.8	130
900	4.5	60.8	15	4300	21.5	290.3	73	7800	39	526.5	132
1000	5	67.5	17	4400	22	297.0	74	7900	39.5	533.3	133
1100	5.5	74.3	19	4500	22.5	303.8	76	8000	40	540.0	135
1200	6	81.0	20	4600	23	310.5	78	8100	40.5	546.8	137
1300	6.5	87.8	22	4700	23.5	317.3	79	8200	41	553.5	138
1400	7	94.5	24	4800	24	324.0	81	8300	41.5	560.3	140
1500	7.5	101.3	25	4900	24.5	330.8	83	8400	42	567.0	142
1600	8	108.0	27	5000	25	337.5	84	8500	42.5	573.8	143
1700	8.5	114.8	29	5100	25.5	344.3	86	8600	43	580.5	145
1800	9	121.5	30	5200	26	351.0	88	8700	43.5	587.3	147
1900	9.5	128.3	32	5300	26.5	357.8	89	8800	44	594.0	149
2000	10	135.0	34	5400	27	364.5	91	8900	44.5	600.8	150
2100	10.5	141.8	35	5500	27.5	371.3	93	9000	45	607.5	152
2200	11	148.5	37	5600	28	378.0	95	9100	45.5	614.3	154
2300	11.5	155.3	39	5700	28.5	384.8	96	9200	46	621.0	155
2400	12	162.0	41	5800	29	391.5	98	9300	46.5	627.8	157
2500	12.5	168.8	42	5900	29.5	398.3	100	9400	47	634.5	159
2600	13	175.5	44	6000	30	405.0	101	9500	47.5	641.3	160
2700	13.5	182.3	46	6100	30.5	411.8	103	9600	48	648.0	162
2800	14	189.0	47	6200	31	418.5	105	9700	48.5	654.8	164
2900	14.5	195.8	49	6300	31.5	425.3	106	9800	49	661.5	165
3000	15	202.5	51	6400	32	432.0	108	9900	49.5	668.3	167
3100	15.5	209.3	52	6500	32.5	438.8	110	10000	50	675.0	169
3200	16	216.0	54	6600	33	445.5	111	10100	50.5	681.8	170
3300	16.5	222.8	56	6700	33.5	452.3	113	10200	51	688.5	172
3400	17	229.5	57	6800	34	459.0	115				
3500	17.5	236.3	59	6900	34.5	465.8	116				
				7000	35	472.5	118				

1-L bottles needed				cone dosage (mL)						
1	37	39	42	45	48	51	53	56	59	62
1.5	56	59	63	68	72	76	80	84	88	93
2	74	79	84	90	96	101	107	113	118	124
2.5	93	98	105	113	120	126	133	141	147	155
3	111	118	127	135	144	152	160	169	177	186
3.5	130	138	148	158	168	177	187	197	206	217
4	148	157	169	180	191	202	213	225	236	248
4.5	167	177	190	203	215	228	240	253	265	279
5	185	197	211	225	239	253	267	281	295	310
5.5	204	216	232	248	263	278	293	309	324	341
6	223	236	253	270	287	303	320	338	354	372
6.5	241	256	274	293	311	329	347	366	383	403
7	260	276	295	315	335	354	374	394	413	433
7.5	278	295	316	338	359	379	400	422	442	464
8	297	315	338	360	383	404	427	450	472	495
8.5	315	335	359	383	407	430	454	478	501	526
9	334	354	380	405	431	455	480	506	531	557
9.5	352	374	401	428	455	480	507	534	560	588
10	371	394	422	450	479	506	534	563	590	619
10.5	389	413	443	473	503	531	560	591	619	650
11	408	433	464	495	527	556	587	619	648	681
11.5	427	453	485	518	551	581	614	647	678	712
12	445	472	506	540	574	607	640	675	707	743
12.5	464	492	527	563	598	632	667	703	737	774
13	482	512	548	585	622	657	694	731	766	805
13.5	501	531	570	608	646	683	720	759	796	836
14	519	551	591	630	670	708	747	788	825	867
14.5	538	571	612	653	694	733	774	816	855	898
15	556	590	633	675	718	758	800	844	884	929
15.5	575	610	654	698	742	784	827	872	914	960
16	593	630	675	720	766	809	854	900	943	991
16.5	612	649	696	743	790	834	880	928	973	1022
17	630	669	717	765	814	860	907	956	1002	1053
17.5	649	689	738	788	838	885	934	984	1032	1084
decap density (g/mL)	0.364	0.343	0.320	0.300	0.282	0.267	0.253	0.240	0.229	0.218

How to determine your feed dosages

artemia

Lila Solnica-Krezel (and lab members)
Stephen Canter
Kathleen and Finley Sanker-Sanders
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Christian Lawrence
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