

# Recent Advances in Research of Marine Myxozoans

Oswaldo Palenzuela

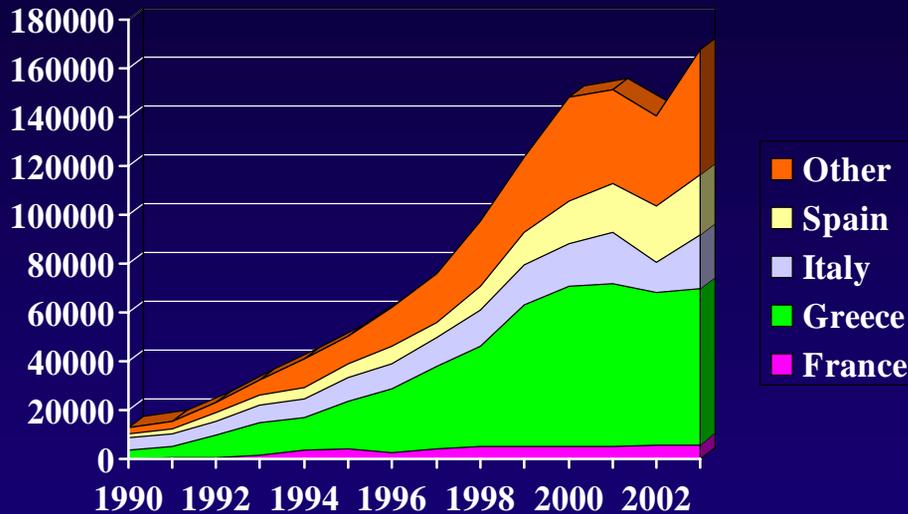


Instituto de Acuicultura de Torre la Sal  
*Consejo Superior de Investigaciones  
Científicas*

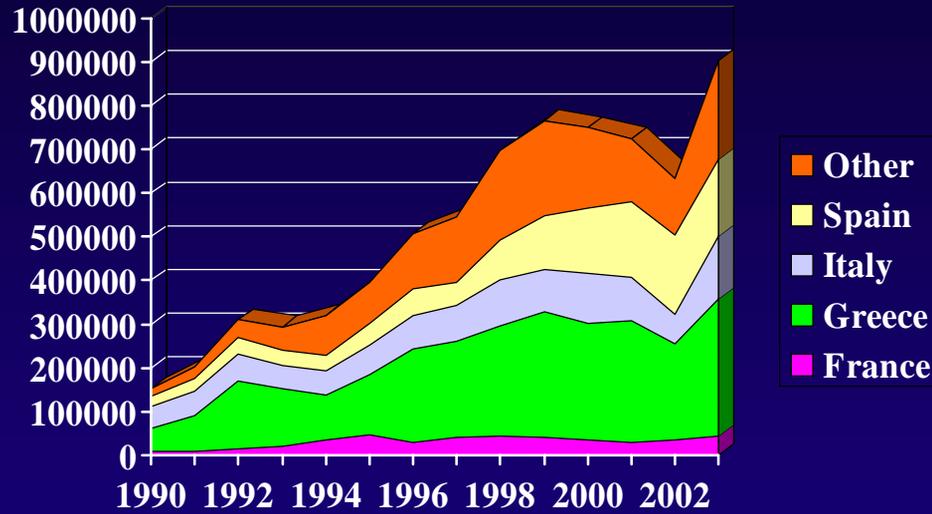


# European Finfish Mariculture Industry (1990-2003)

Production in Tm



Value in k€



Main contributors to "others": Portugal, Cyprus, Malta, Mauritania Croatia, Tunisia, and, Turkey.

**12-fold increase (1184%)**  
**"Other" from 19% to >30%**

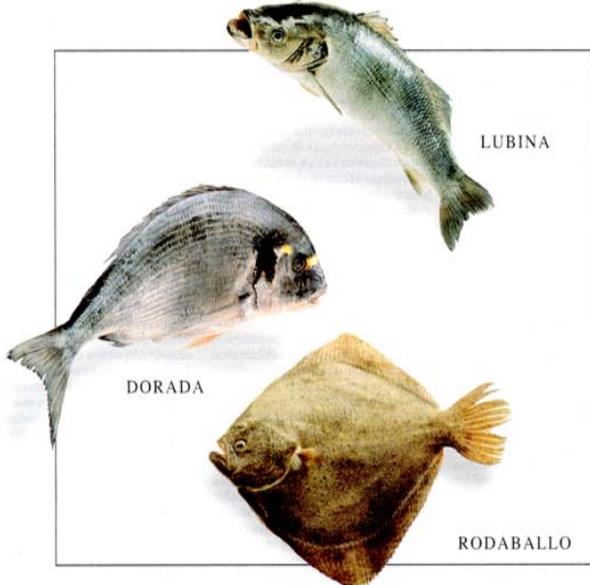
**5-fold increase (493%) [\*\*]**  
**"Other" from 11% to 25%**

# Current Mediterranean Mariculture

- Focused on few fish species for which basic husbandry and handling routines are developed.
- Signs of market saturation (price drop). Low profitability.
- Diversification to new species at industrial scale with poor background knowledge (high risk).
- Increasing competence and single market. Pressure to reduce operation costs. Scarce areas for new facilities.
- Explosive growth of intensive culture in netpens over other models.

PESCADO CRIADO EN PLENA NATURALEZA

PESCADO DE CRIANZA.  
TAN FRESCO QUE SALTA A LA VISTA.



LUBINA

DORADA

RODABALLO

Los pescados de crianza van a traer cola, porque tienen la mar de ventajas para Ud., para su negocio y para sus clientes.

¿Se imagina poder ofrecer durante todo el año Doradas, Lubinas y Rodaballos con total garantía de calidad y frescura a un precio estable y con un tamaño y peso ideales?

Por todos estos motivos y otros que iremos descubriéndoles a Ud. como protector de la reserva marina, hágase a la mar y recomiende a sus clientes pescados de crianza de nuestros mares ...van a traer cola.

**Pescado de crianza. Salta a la vista**

Para más información diríjase a APROMAR: Asociación Empresarial de Productores de Cultivos Marinos. Tel: 91 555 37 81 - Fax: 91 556 02 12.



MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN

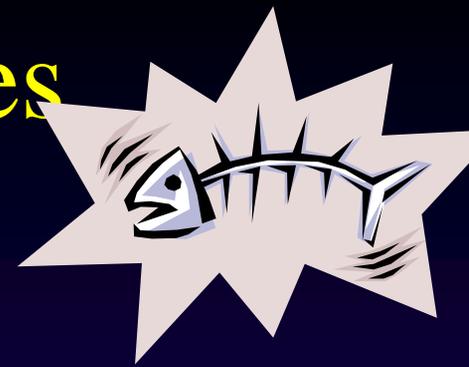
APROMAR O.P.30

COMUNIDAD EUROPEA

Instrumento Financiero de Orientación de la Pesca

<http://www.from.es>

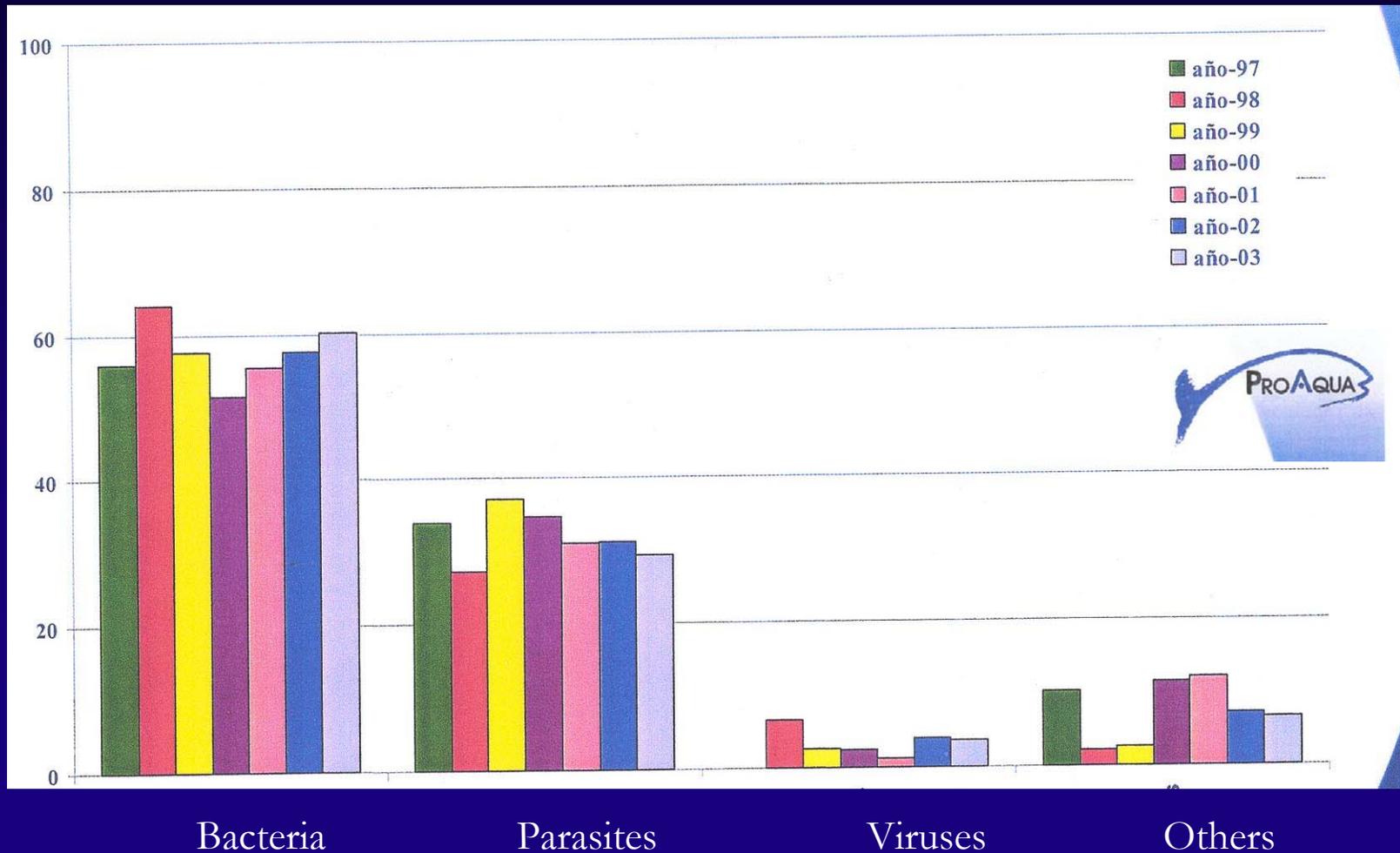
# Causes and Consequences



- Very high stocking density
- Low genetic diversity
- Accessibility of pathogens and easiness of transmission
- Of all etiological agents, parasites are specially fastidious:
  - Treatments unavailable, difficult, and/or expensive. No vaccines
  - Basic knowledge on parasites scarce (life cycles, biochemistry, etc.)
  - Obstacle to production and profitability of cultures, and threat for introduction of new species



# Relative importance of parasitic etiologies in marine pisciculture



# Relative importance of parasitic etiologies in fish mariculture

- ❖ Primary pathogens. Causing direct or indirect mortality (in association with opportunistic pathogens).
- ❖ Sublethal pathogens. Responsible for low growth rates and productivity, low quality of final product and increased production costs.
- ❖ Indeterminate status species: having potential to belong to either class but not enough data is available.
- ❖ Aquaculture changes natural ecologic balance by concentrating large fish biomasses with poor genetic diversity under stress. This favours host-captures and switches from one category to another. New fish species or new farming models can be seriously hampered by emerging parasites, so far innocuous in other circumstances.

3.  
5 al 21 ambos inclusive.  
23, 25, 30 y 31.

Parcelas de los siguientes polígonos:

Polígono 2: 21, 23, 79, 81, 82, 84, 92, 115, 123B, 126, 131, 136, 181A, 184.

192, 211, 245, 247, 2

Polígono 22: 35,

193, 194, 195, 199, 2

Polígono 24: 22;

Polígono 25: 104

y 188.

Polígono 27: 10x

B.

Polígono 29: 39, 1

179, 181, 182 y 185.

Zona B:

Resto de los poli

parcelas correspon

Polígono 27: 106

20 abril 2005

6376

**RESOLUCIÓN de 15 de marzo de 2005, de la Dirección General de Seguros y Fondos de Pensiones, por la que se publican las condiciones especiales del seguro de acuicultura marina para dorada, lubina y rodaballo, incluido en el Plan de Seguros Agrarios Combinados para el ejercicio 2005.**

**De conformidad con el Plan de Seguros Agrarios Combinados para el**

Polígonos catastrales completos:

75 al 84 ambos inclusive.

111 al 117 ambos inclusive.

Parcelas de los siguientes polígonos:

Polígonos 85 y 86: Todas las parcelas, excepto las consignadas de estos polígonos en zona B.

Polígono 96: 35, 36, 60 y 87.

Polígono 101: 21, 37, 60.

Polígono 102: 10.

Polígono 103: 5 y 22.

Polígono 104: 3 y 11.

Polígono 105: 9 y 31P.

Polígono 106: 3, 12, 26, 31, 32, 30A, 30B, 50, 54, 56, 65, 66, 68, 70A, 72, 73, 77A y 77B.

Polígono 108: 24, 32, 35, 96, 97 y 88.

Polígono 109: 6, 8, 44A, 47A y 47B.

Polígono 110: 2, 8B, 13 y 15.

Polígono 118: 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

Zona B:

Resto de los I

parcelas no in

110, 118, 128 y 12

Polígono 85: 3

Polígono 96: 4

**Condiciones especiales del Seguro de Acuicultura Marina**

**De conformidad con el Plan Anual de Seguros de 2005, aprobado por Consejo de Ministros, se garantiza la producción de Dorada, Lubina y Rodaballo, contra los riesgos siguientes: variaciones excepcionales de**

Zona A:

Polígonos Catastrales números 12, 13 y 14. Se excluyen de esta zona, las parcelas comprendidas en la Zona B, de los polígonos números 12 y 13.

Zona B:

Resto de los polígonos catastrales no incluidos en la Zona A, así como las siguientes parcelas correspondientes a:

Polígono 12: Parcela número 77.

Polígono 13: Parcelas números 127, 142, 189, 203, 204, 205 y 209.

6376

**RESOLUCIÓN de 15 de marzo de 2005, de la Dirección General de Seguros y Fondos de Pensiones, por la que se publican las condiciones especiales del seguro de acuicultura marina para dorada, lubina y rodaballo, incluido en el Plan de Seguros Agrarios Combinados para el ejercicio 2005.**

esta Dirección General ha resuelto publicar las condiciones especiales del mencionado seguro, incluido en el Plan de Seguros Agrarios Combinados para el ejercicio 2005. Las condiciones especiales citadas figuran en el anexo incluido en esta Resolución.

Contra la presente Resolución se podrá interponer recurso de alzada, en el plazo de un mes, ante el Excmo. Sr. Secretario de Estado de Economía, como órgano competente para su resolución, o ante esta Dirección General de Seguros y Fondos de Pensiones, la cual, de conformidad con lo dispuesto en el artículo 114 de la Ley de Régimen Jurídico de las Administraciones Públicas y del Procedimiento Administrativo Común, de 26 de noviembre de 1992, según redacción dada por la Ley 4/1999, de 13 de enero, lo remitirá al órgano competente para resolverlo; todo ello de conformidad con lo dispuesto en los artículos 107 y siguientes de dicha Ley.

Madrid, 15 de marzo de 2005.-El Director General, Ricardo Lozano Aragón.

ANEXO I

Condiciones especiales del Seguro de Acuicultura Marina

ANEXO I

Contra los riesgos siguientes: variaciones excepcionales de las condiciones especiales vigésimo segunda y vigésimo cuarta.

A efectos del Seguro, se distinguen cinco tipos de establecimientos de cultivos marinos:

- Tipo 1: Viveros (Jaulas) y plataformas marinas.
- Tipo 2: Intensivo en tanques.
- Tipo 3: Unidades de crianza (engorde) en tierra (crianza semiintensiva en naves y canales; esteros).
- Tipo 4: Hatchery-Nursery.
- Tipo 5: Viveros (Jaulas) sumergidos para crianza (engorde) de rodaballo.

BOE núm. 94

CUADRO I

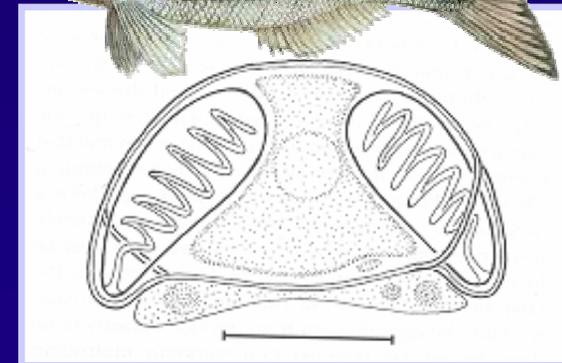
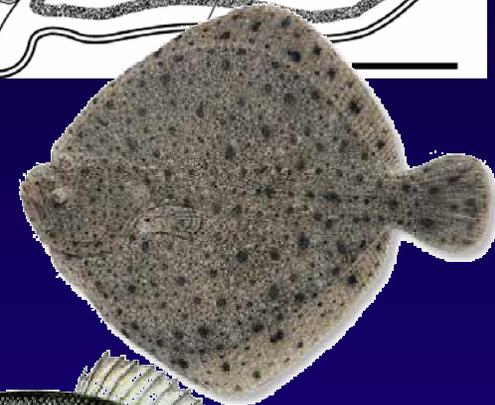
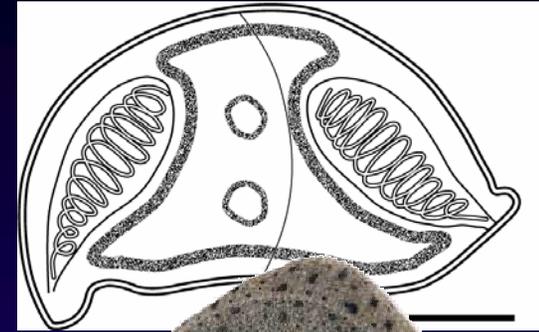
Tipo de establecimiento	Garantías básicas	Garantías adicionales
Viveros (Jaulas) y plataformas marinas.	*Contaminación química y biológica. *Marea negra. *Temporales. *Impacto de barcos y elementos a la deriva.	D) *Variaciones excepcionales de temperatura. *Depredadores marinos.  ID) [Redacted]
Intensivo en tanques.	*Contaminación química y biológica. *Marea negra. *Rayo, incendio o explosión. *Viento huracanado.	D) *Variaciones excepcionales de temperatura. *Descenso de salinidad por lluvia torrencial. *Inundación, avenida o riada.  ID) [Redacted]
Semiintensivo en naves y canales (esteros).	*Contaminación química y biológica. *Marea negra. *Variaciones excepcionales de temperatura. *Descenso de salinidad por lluvia torrencial.	D) *Viento huracanado. *Inundación, avenida o riada. *Rayo, incendio o explosión.  ID) [Redacted]
Hatchery/Nursery.	*Contaminación química y biológica. *Marea negra. *Rayo, incendio o explosión. *Viento huracanado.	D) *Variaciones excepcionales de temperatura. *Descenso de salinidad por lluvia torrencial. *Inundación, avenida o riada.  ID) [Redacted]
Viveros (Jaulas) sumergidos para crianza (engorde) de rodaballo.	*Contaminación química y biológica. *Marea negra. *Temporales. *Impacto de barcos y elementos a la deriva.	D) *Variaciones excepcionales de temperatura. *Descenso de salinidad por lluvia torrencial. *Depredadores marinos.  ID) [Redacted]

Tipo de enfermedades	Enfermedad	Especies Cubiertas
Bacterianas.	Pasteurellosis (1). Mycobacteriosis. Mixobacteriosis. Vibriosis (V. anguillarum) (1). [Redacted] (Paramoeba pemakuidensis). [Redacted] (Uronema). Endoparasitosis a causa de: [Redacted]	Dorada, lubina y rodaballo. Dorada, lubina. Dorada, lubina y rodaballo. Lubina.  Rodaballo.  Rodaballo.  Dorada, lubina y rodaballo.
Víricas.	Todas.	Dorada. Lubina. Rodaballo.

(1) Estas enfermedades estarán garantizadas cuando habiéndose aplicado la vacunación pertinente, ésta no haya dado el resultado esperado.

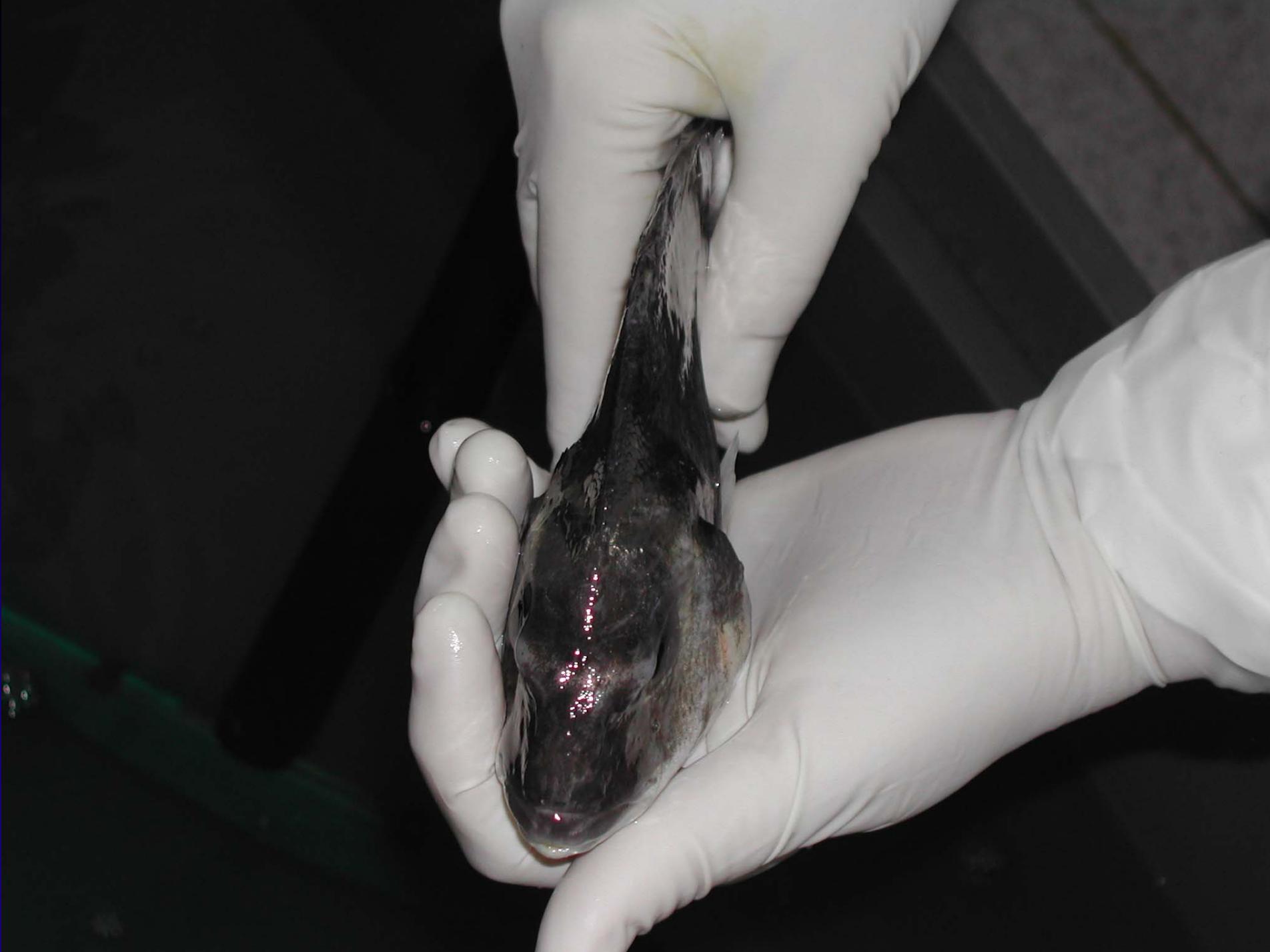
# Parasitic Enteritis: Enteromixosis

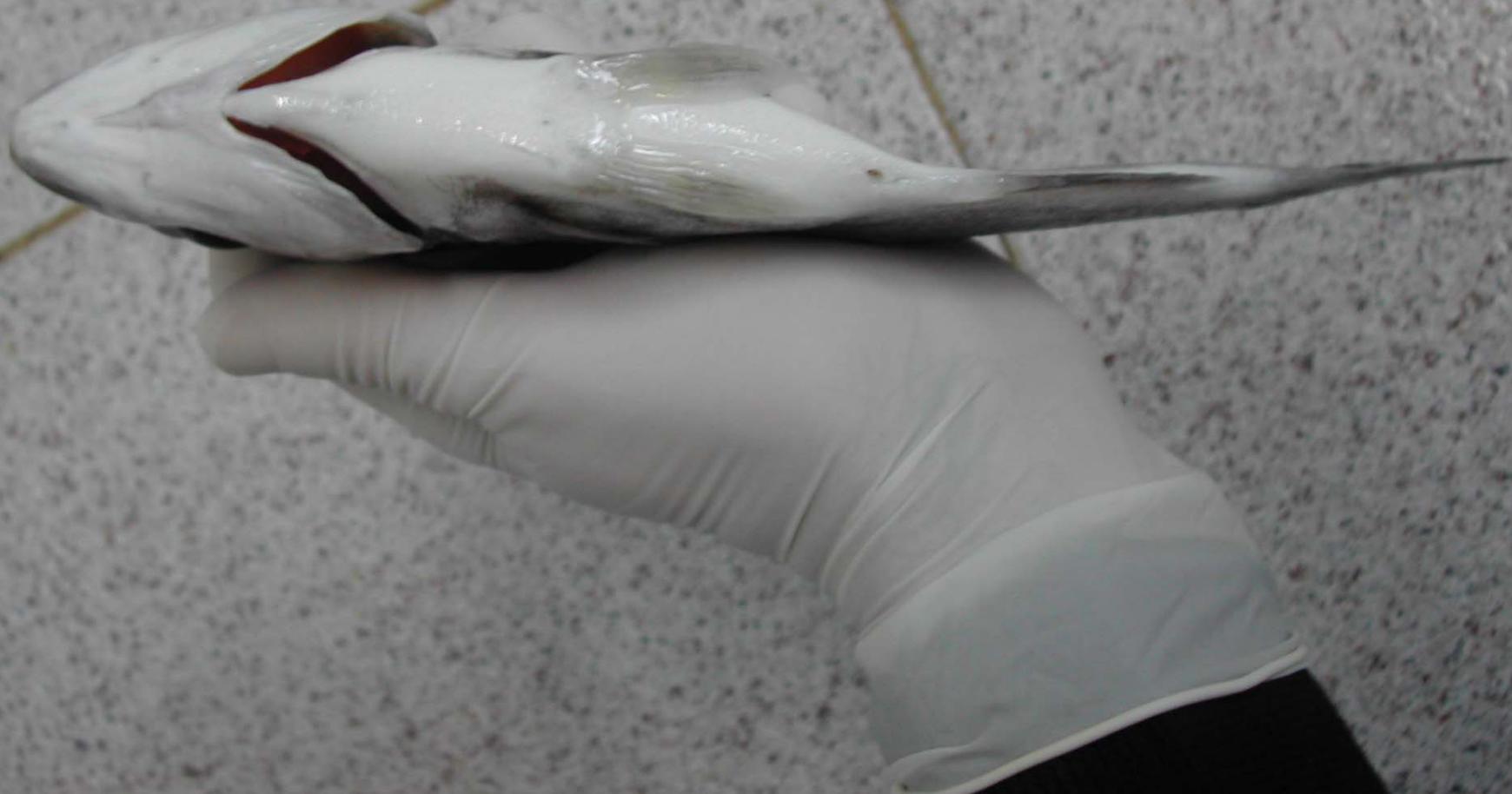
- Emaciative disease or parasitic enteritis due to *Enteromyxum* spp. One species in turbot (*E.scophthalmi*) and another in a large number of fish hosts.
- The parasite invades the intestinal tract causing descamative enteritis with cachexia and death of up to 100% of susceptible stocks.
- Characteristic prominent bony ridges due to atrophy of muscle. Intestinal walls thin, transparent, sometimes focal congestion and accumulation of liquid in the lumen. Large numbers of spores in *E.leei*, but very scarce in *E.scophthalmi* (only in terminal infections).
- Very variable susceptibility in different fish species.

















# Labridae (*Symphodus* spp.)

*S. tinca*



*S. mediterraneus*



*S. rostratus*



*S. ocellatus*



*S. cinereus*



*S. roissali*



*S. melops*

# Labridae



*Coris julis*



*Xyrichthys novacula*



*Thalassoma pavo*



*Labrus merula*



*Labrus bergylta*



*Labrus viridis*

# Centracanthidae, Sparidae, Mullidae, Pomacentridae, Scorpaenidae...



*Spicara maena*



*Diplodus sargus*



*Diplodus vulgaris*



*Mullus surmuletus*



*Chromis chromis*



*Scorpaena porcus*

# Molidae, Blenniidae, Gobiidae...



*Mola mola*



*Gobius niger*



*Parablennius zvonimiri*



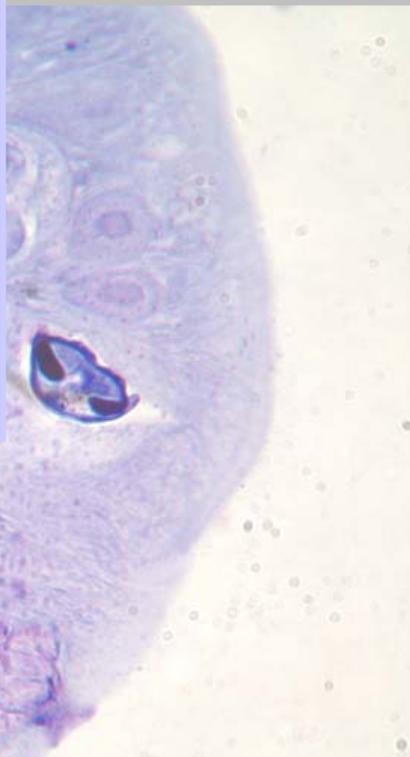
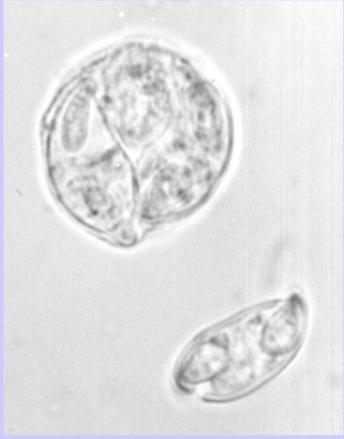
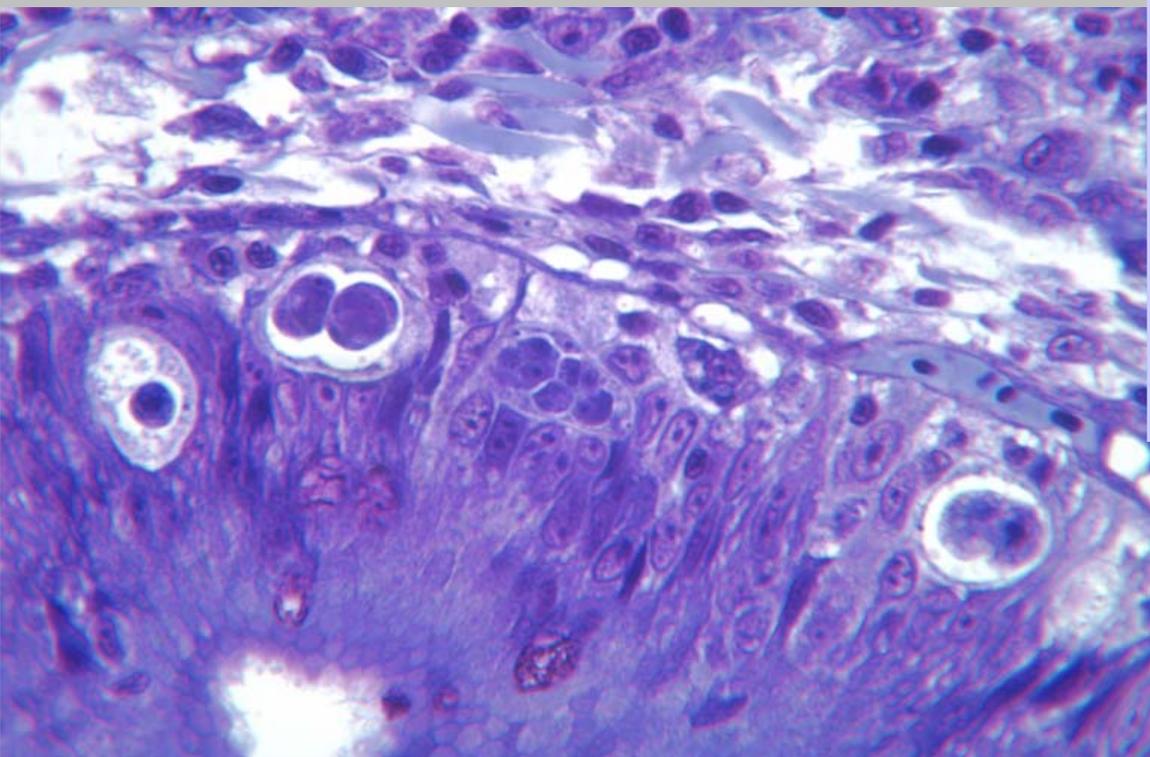
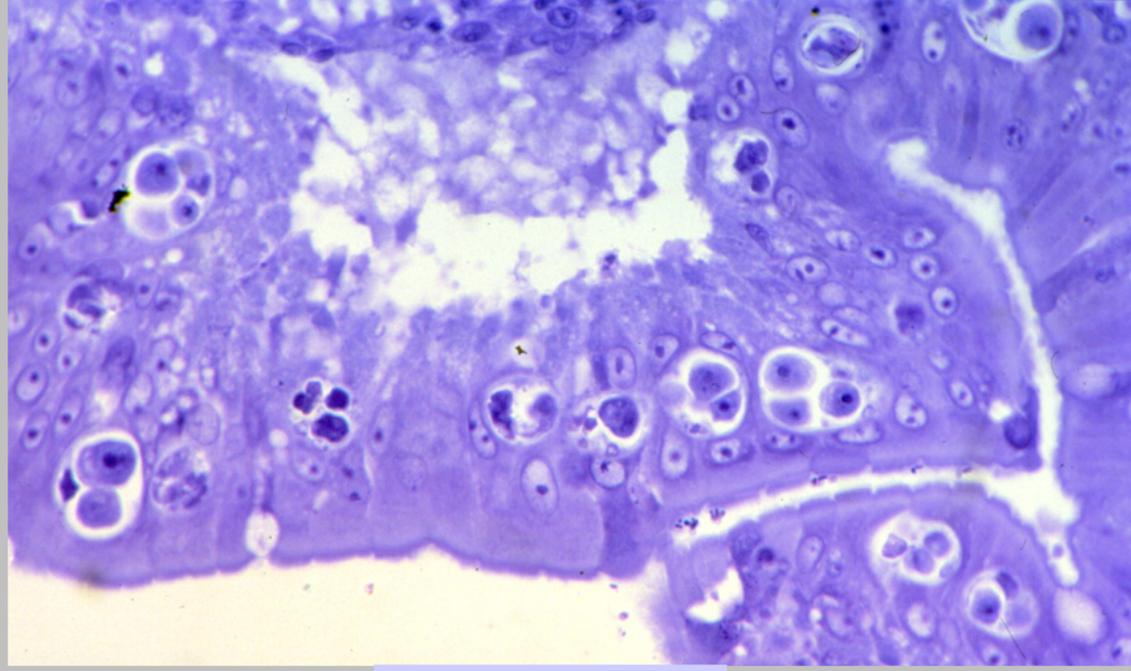
*Lipophrys pavo*



*Scartella cristata*





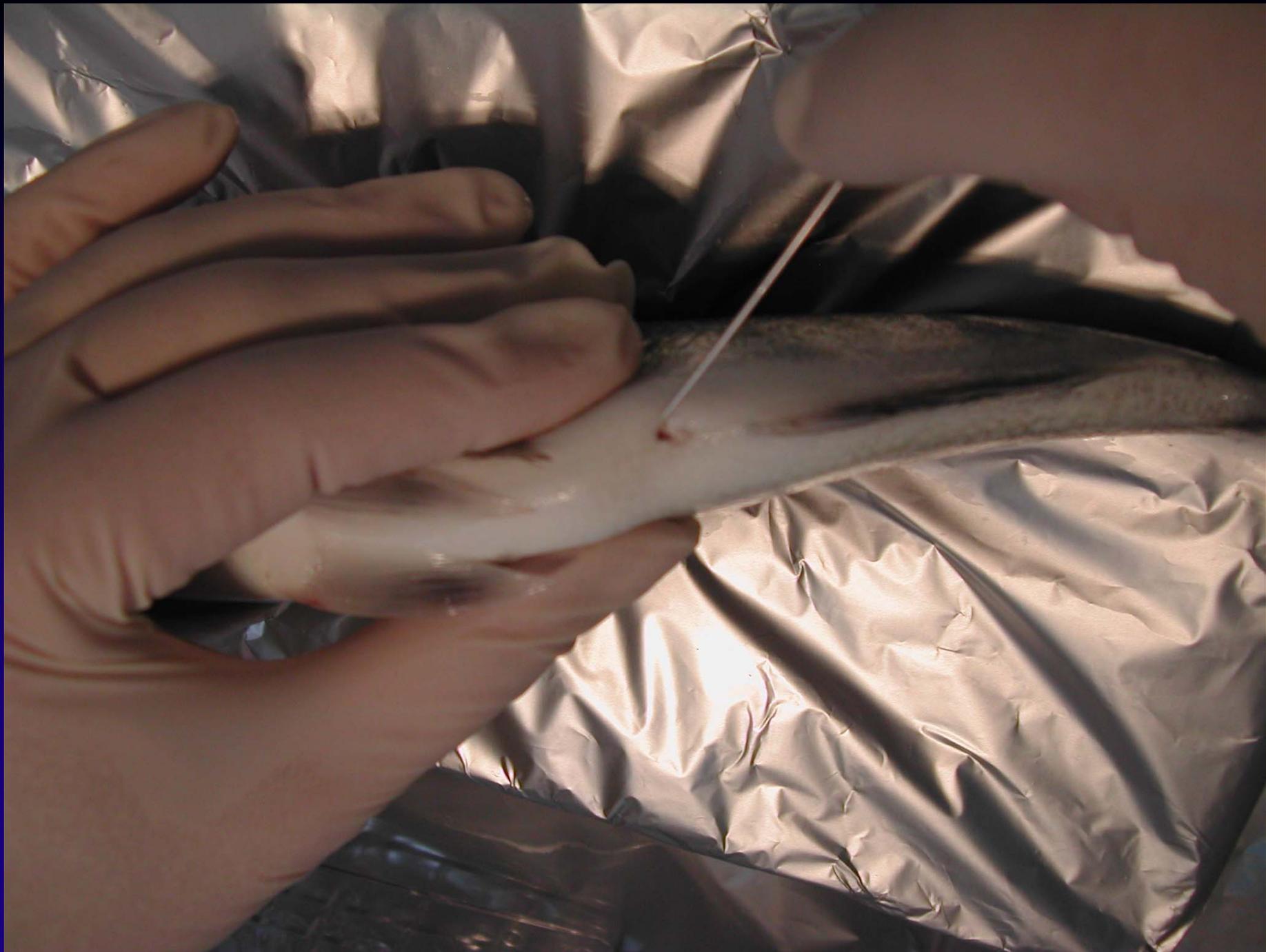


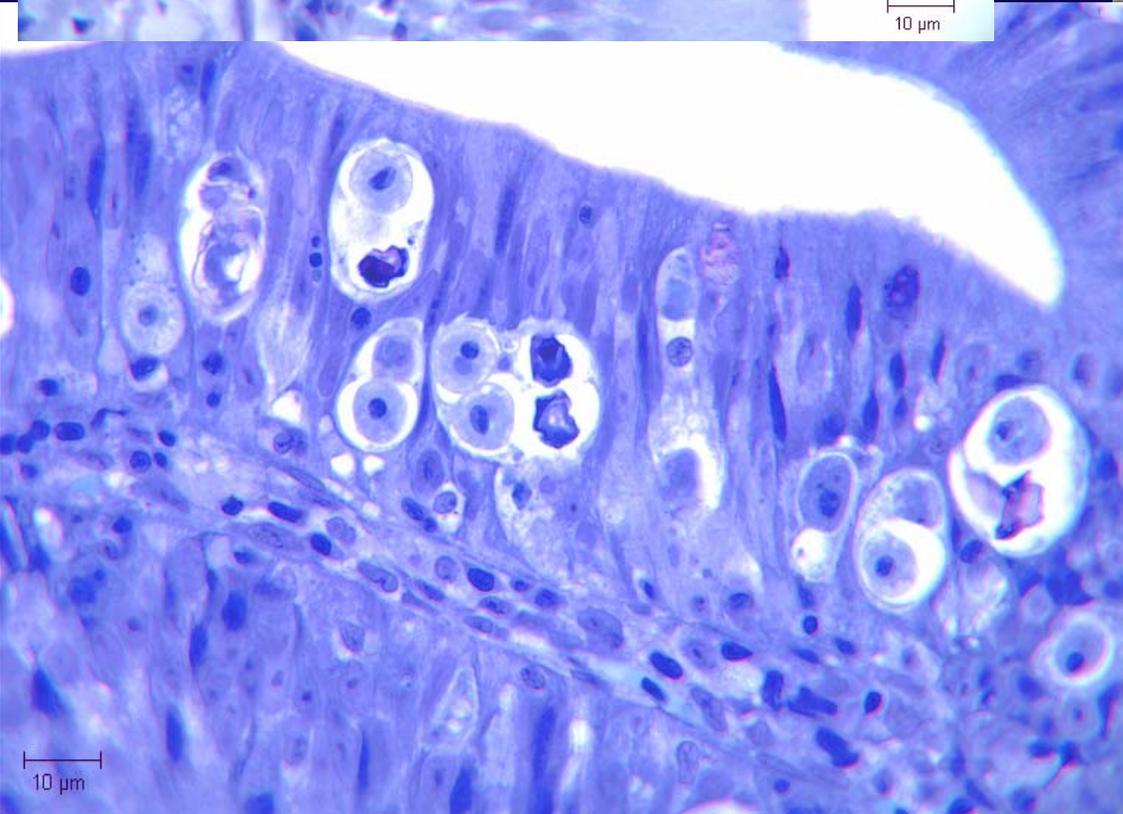
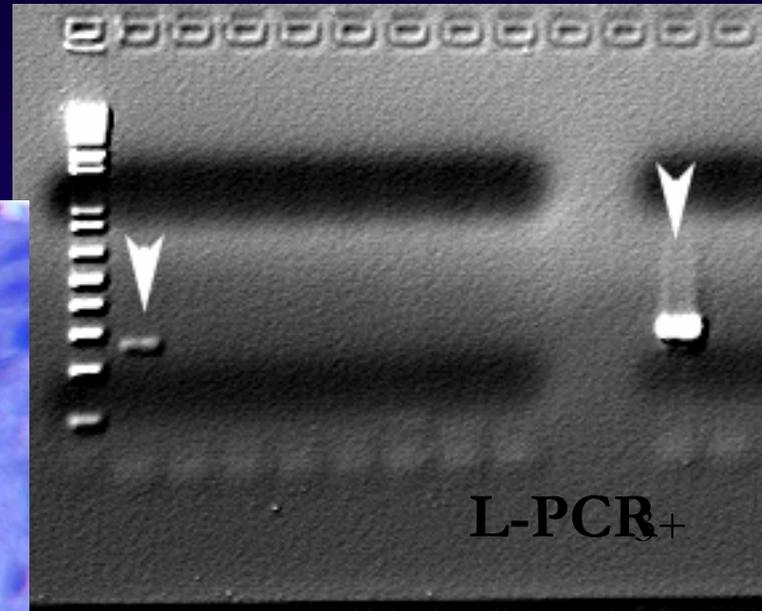
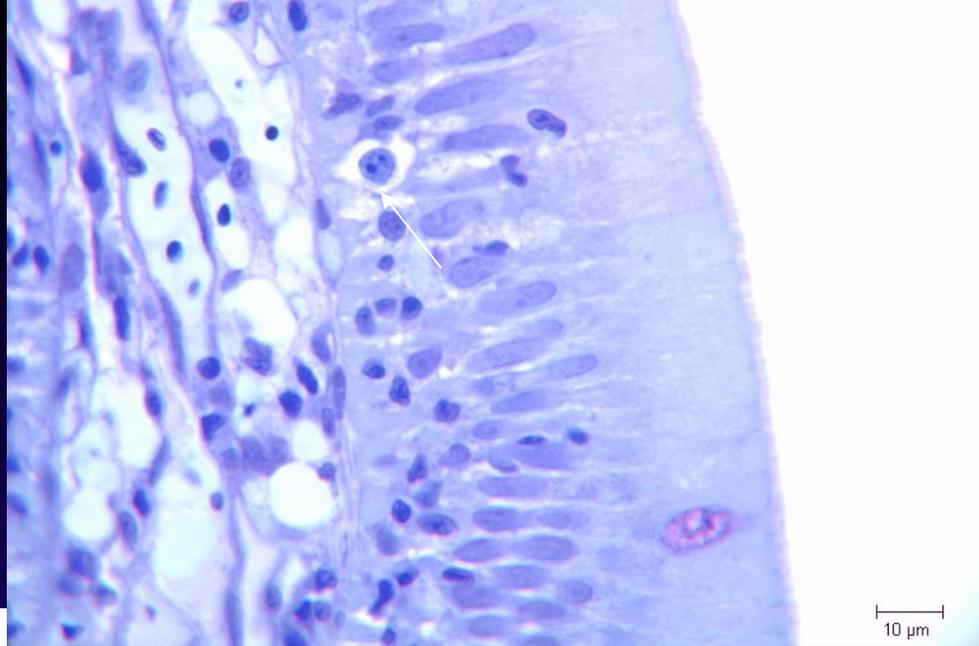
# Validation of a PCR-based diagnostic tests: experimental design

- **Fish Sampling:**
  - Non-lethal swabs (PCR NL)
  - Small pieces of intestine (Rt & Im)
  - Entire digestive for histology
- **Blinding of samples: random mixing in lots**
- **Processing and analyses of the samples in a “blind” fashion.**
  - PCR of samples
  - Routine microscopy (four labs)
  - In-depth histopathological study (Gold-standard by consensus of two labs)



Validated test(s)





# Transmission and life cycle

- *E. leei* gets transmitted directly from fish to fish by cohabitation, waterborne contamination or eating infected material. The infective stages are not the spores, but cells present within the developmental cells.
- Parasites cause inflammation and detachment of the intestine epithelial layer. They are then released in foecal casts, together with epithelial debris. They retain viability in sea water for short periods of time.
- Other myxozoans cannot be transmitted directly from fish to fish, needing participation of invertebrates where infective spores are developed. It is possible that *E. leei* has this kind of development in addition to the direct transmission.
- By *E. leei*-specific PCR we have detected assorted positive invertebrates in enzootic sites. Their true meaning is yet to be characterised.
- In intensive mariculture, problems arise due to the direct transmission (with or without participation of feral fish as vectors).

# Epidemiology

- **Wide host range and direct transmission are responsible for current distribution of the disease. The infection has been diagnosed in all kinds of facilities.**
- **The existence of epizootics, their incidence and severity depend on multiple factors but most important are temperature and recirculation.**
- **In *S. aurata* the infection tends to cronify in land-based facilities with some degree of recirculation. There can be trickling mortality in animals >100g. Accumulative mortality can be serious depending on temperature. Growing large *S.aurata* (>500g) is an additional risk factor.**
- **In netpens usually there are not episodes of mortality although these can occur, specially with hot (>20 C) water.**
- ***Diplodus puntazo* is quite sensitive and there is usually severe mortality shortly after introduction in netpens (500-2000 fish/day in 20-50g fish). Enteromyxosis is currently the main limiting factor for its culture.**



# *E. Leei* control



- ❖ No efficacious treatments.
- ❖ No vaccines or possibility to generate them at short/mid term.
- ❖ Potential for genetically resistant fish strains and/or immunoestimulation. Research underway.
- ❖ Control of alternate hosts/infective stages. Research underway but direct transmission is the problem.
- ❖ Currently the only strategies affordable are prevention: avoid risk factors and use early detection of infections to eliminate affected stocks and avoid concentration of infective material.
- ❖ Test stocks from enzootic areas before introducing them to disease-free sites.

# Testicular sphaerosporosis



- Infection restricted to sea bass testes. The myxozoan *Sphaerospora testicularis* develops within the seminiferous tubules.
- Granulomatous lesions and focal necrosis, sometimes extensive. Parasitic castration
- Sometimes abdominal distension and ascitis.
- Apparently no direct mortality but reported higher susceptibility to bacterial infections.



A Foto: C. Zarza



B



A



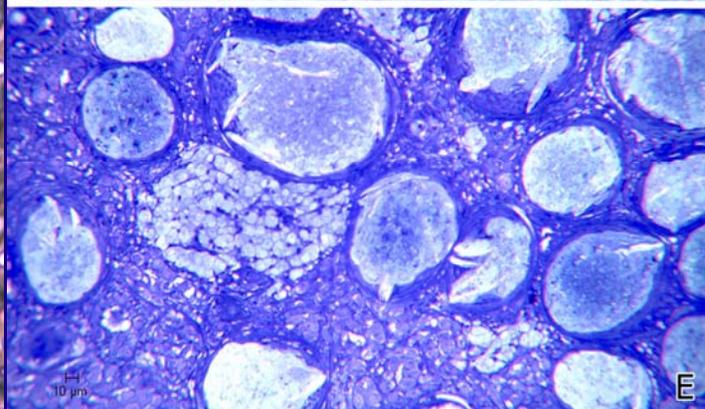
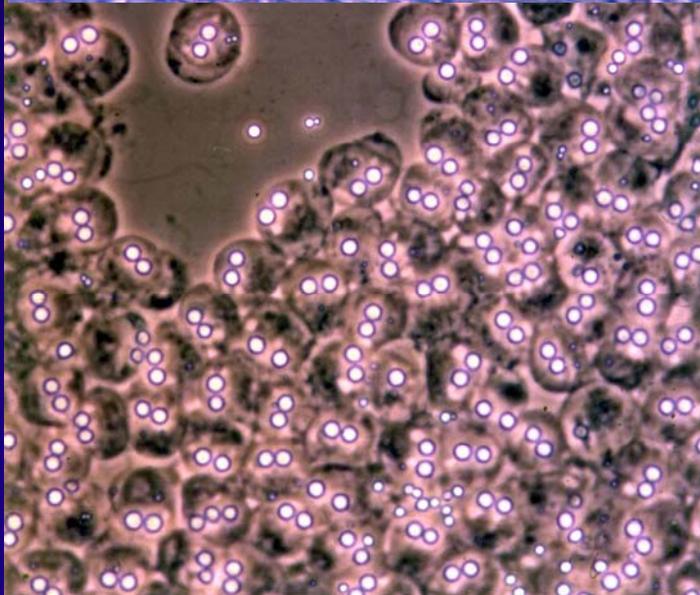
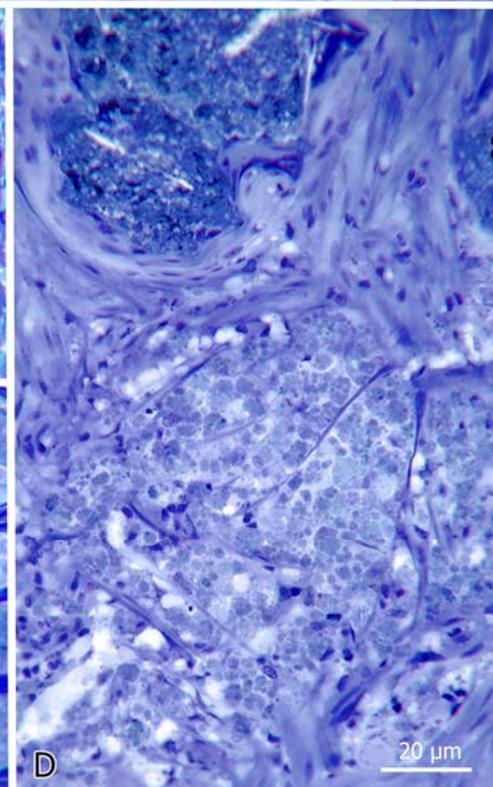
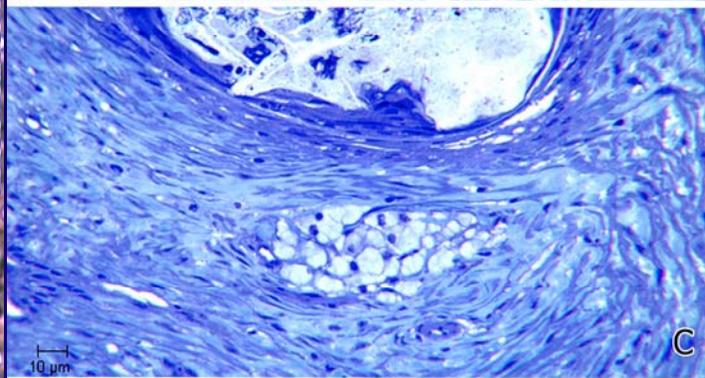
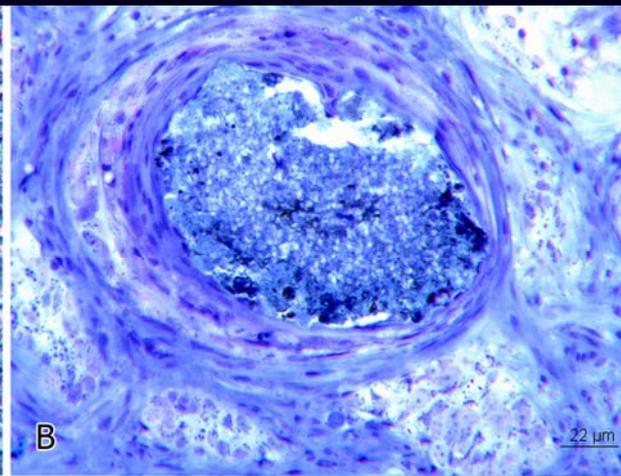
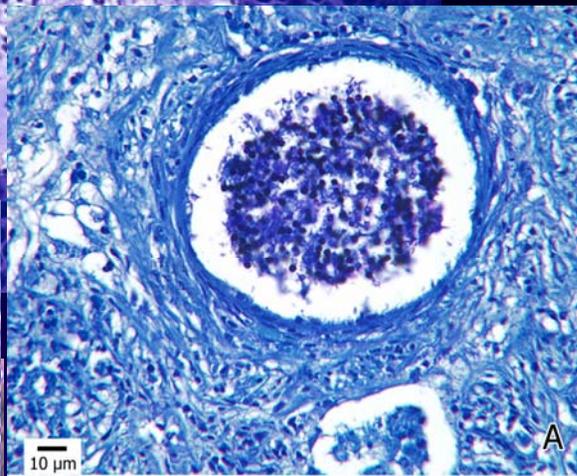
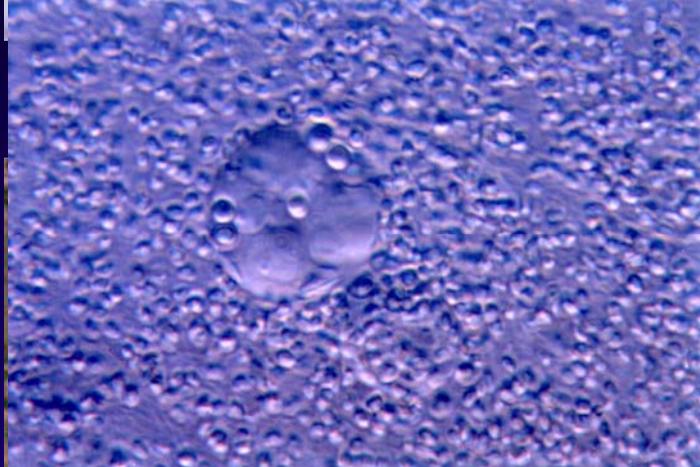
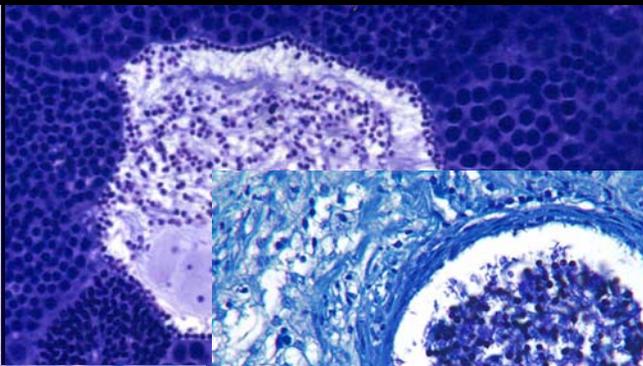
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C



D



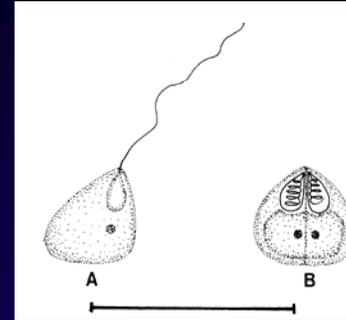
# *Sphaerospora testicularis* (Myxozoa)

- Diagnostics on fresh smears of sperm (only fluent animals) or histology. Experimental PCR test under development & validation.
- Effective treatments not available.
- Unknown life cycle. Possibly intermediate host but direct transmission cannot be completely ruled out. It is unknown whether or not animals can retain infections between seasons.
- Increasingly reported in sea cages (>80% males). Direct impact in ongrowing stocks is unknown, but worrisome.
- Low-quality sperm and castration on valuable broodstock.

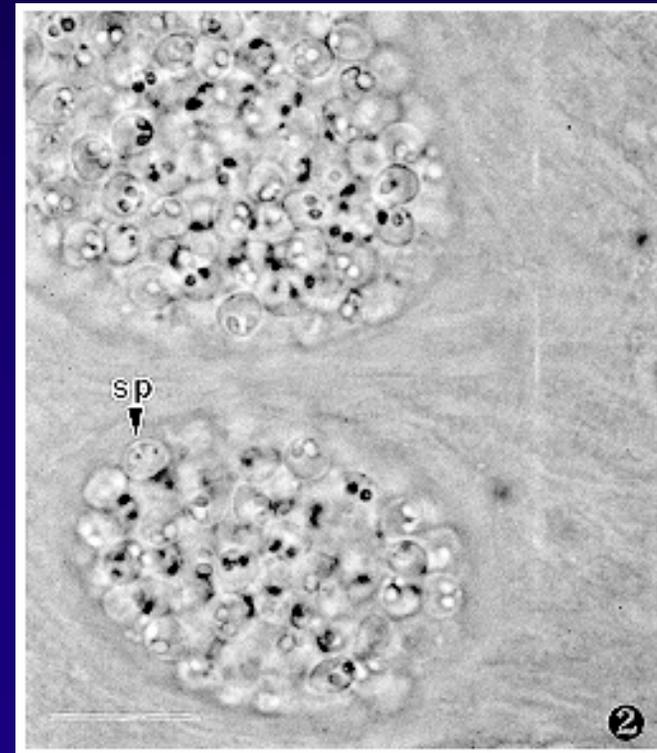
# *Sistemic sphaerosporosis*

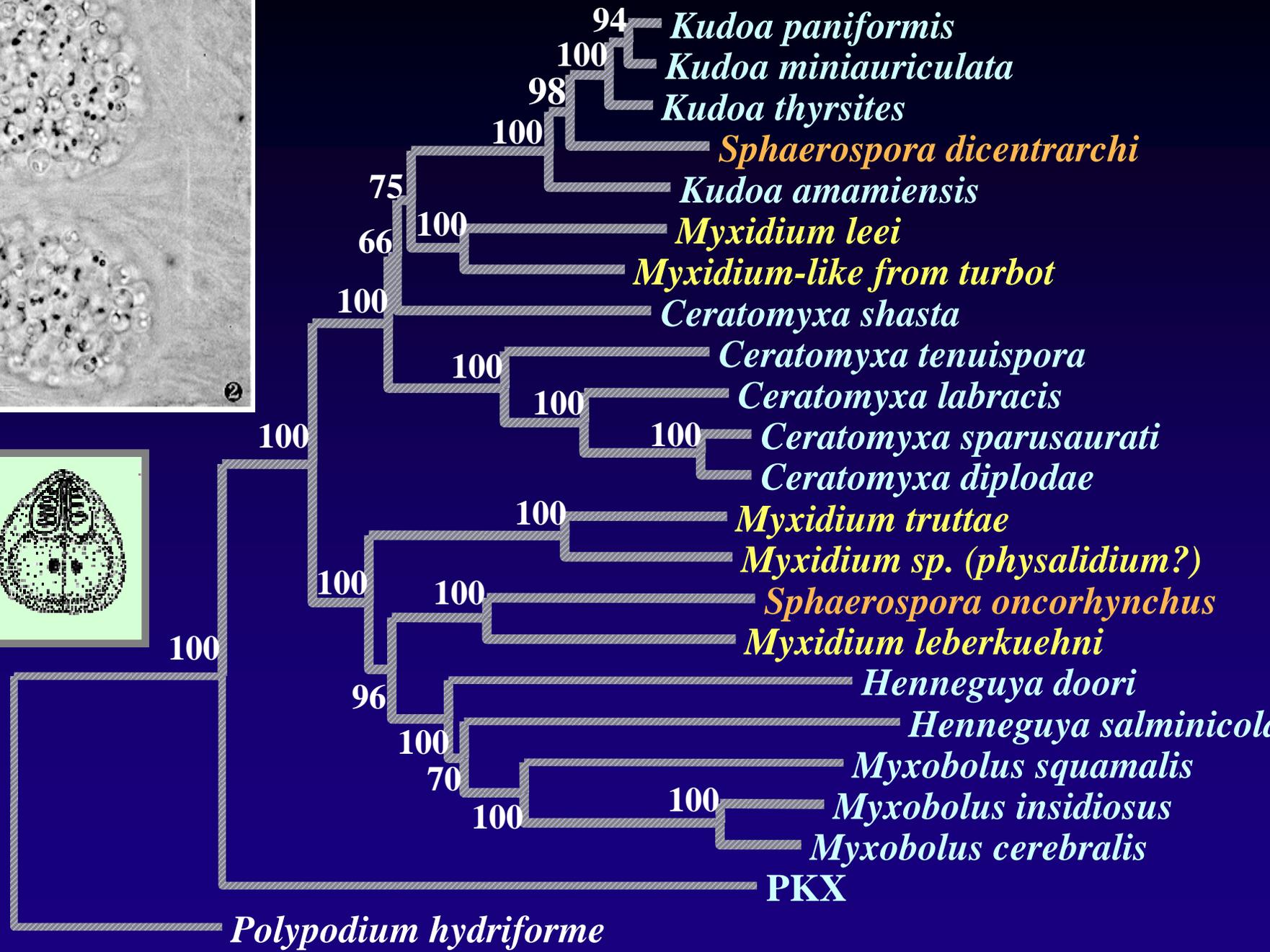
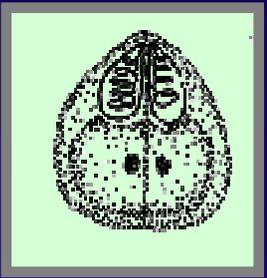
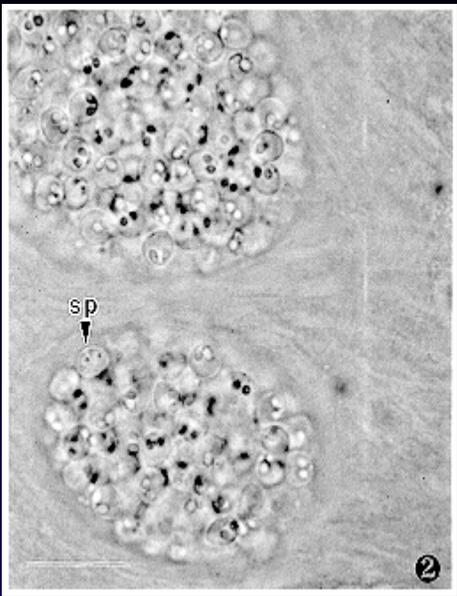


- The mixozoan *Sphaerospora dicentrarchi* infecting connective tissue in sea bass and mugilidae.



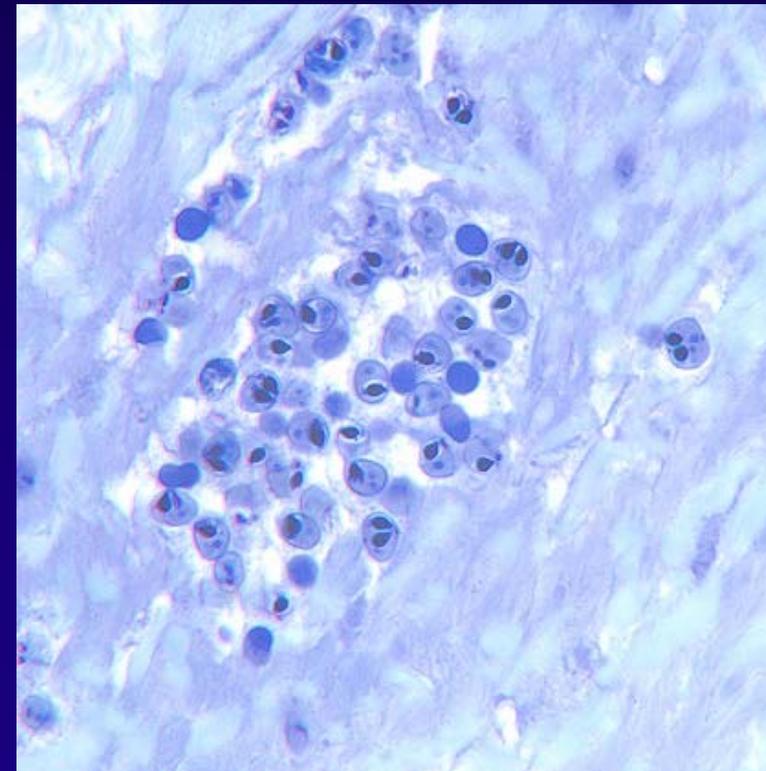
- Very high prevalence in all kinds of facilities, normally 80-100%. Chronic infections.
- Intensity increases with fish age.





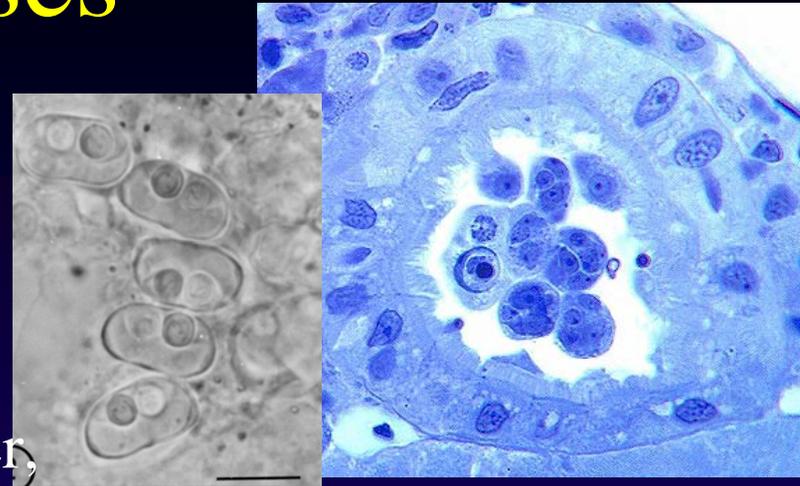
# *Sphaerospora dicentrarchi* (Myxozoa)

- No external symptoms
- Pathogenicity depends on parasitic load and organs affected heavily
- Extensive mortality has been reported in juvenile fish (from 2g) associated to neurological symptoms, anorexia and poor growth. At high temperatures, both tanks and cages, (Eastern Mediterranean).
- Possibly favors bacterial infections, but also has a direct pathogenic effect.
- Life cycle unknown, possibly indirect (invertebrate)
- Effective treatments not available (antibiotics reduced mortality in reported epizootics but data are fragmentary and not contrasted).
- Diagnostic with histology (difficult in fresh smears)

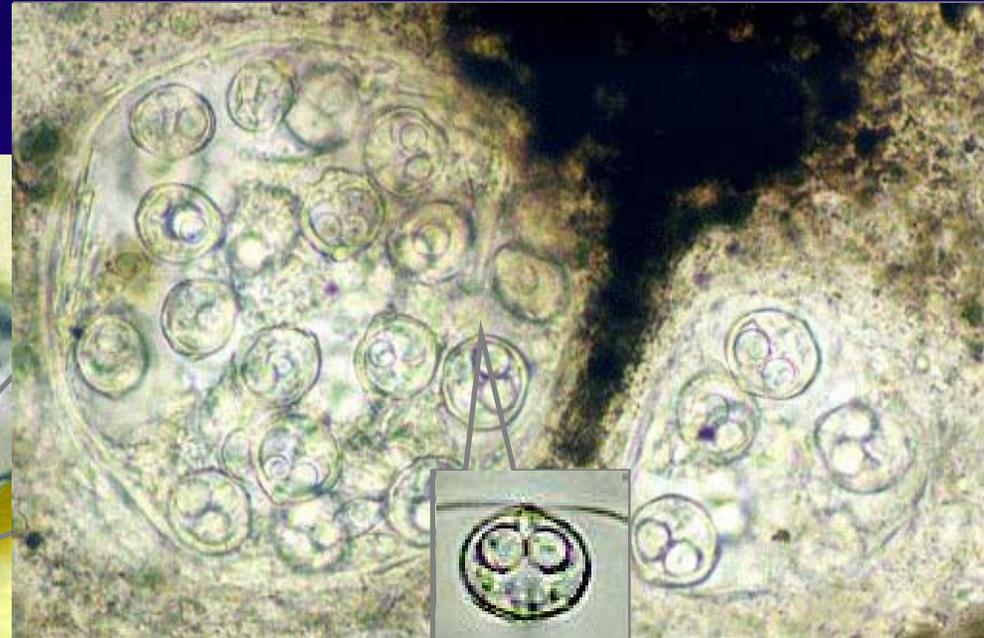


# Kidney mixosporidiosis

- Glomerulonephritis due to *Polysporoplasma sparis* in gilthead sea bream. Kidney inflammation.
- Poor growth and dropping mortality
- High prevalence and intensity in summer, all age classes in on-growing stocks
- Increasing incidence in Eastern Mediterranean & Adriatic



*Leptotheca sparidarum*



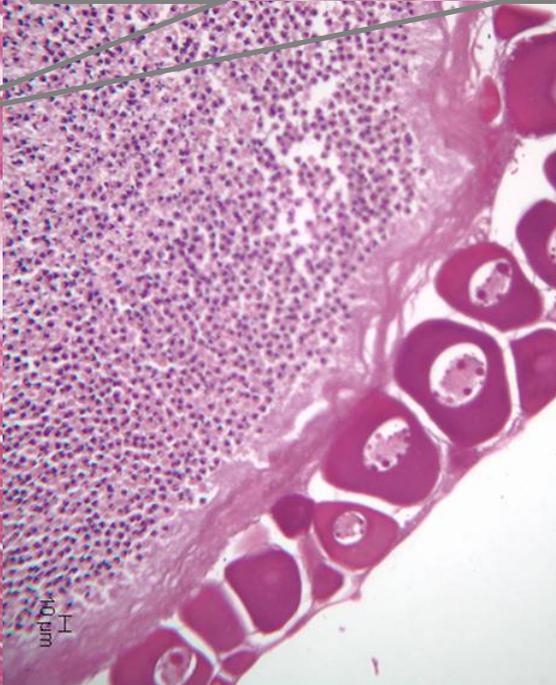
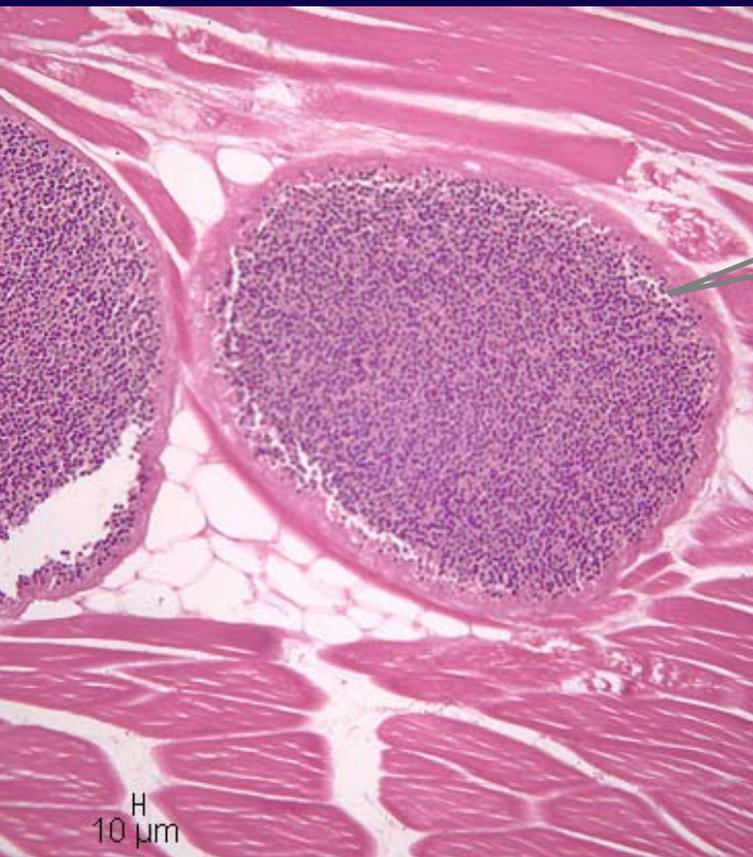
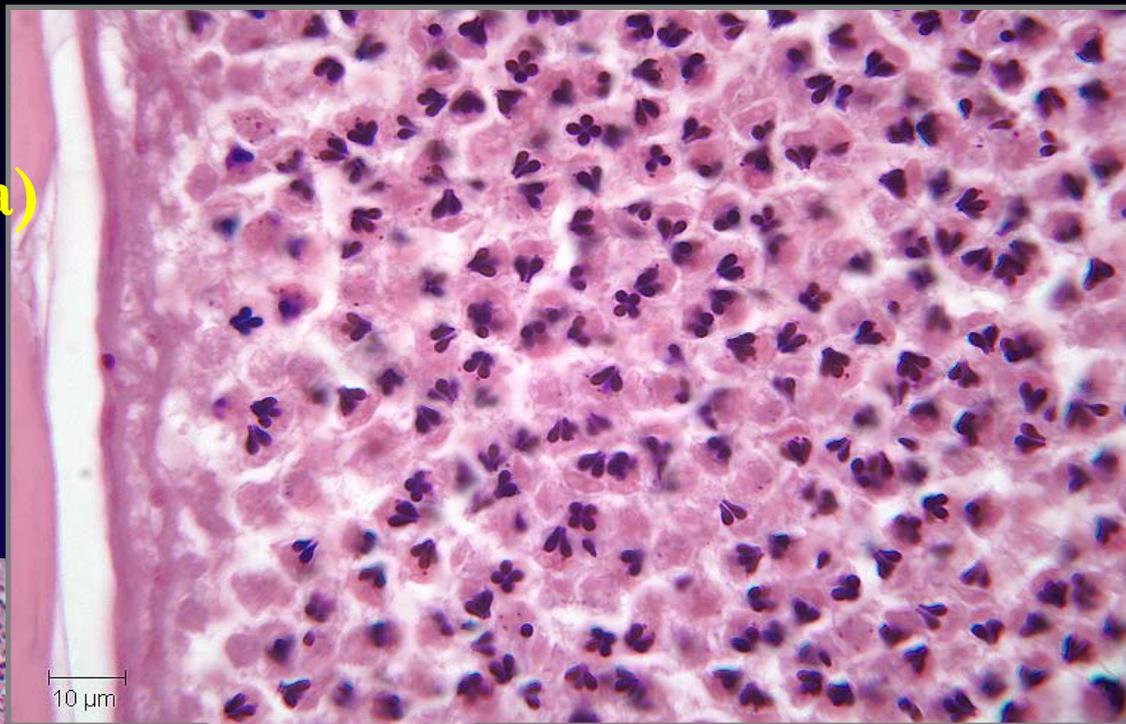
Dr. Panos Varvarigos,  
Vet care, Greece



## *Kudoa iwatai* (Myxozoa)

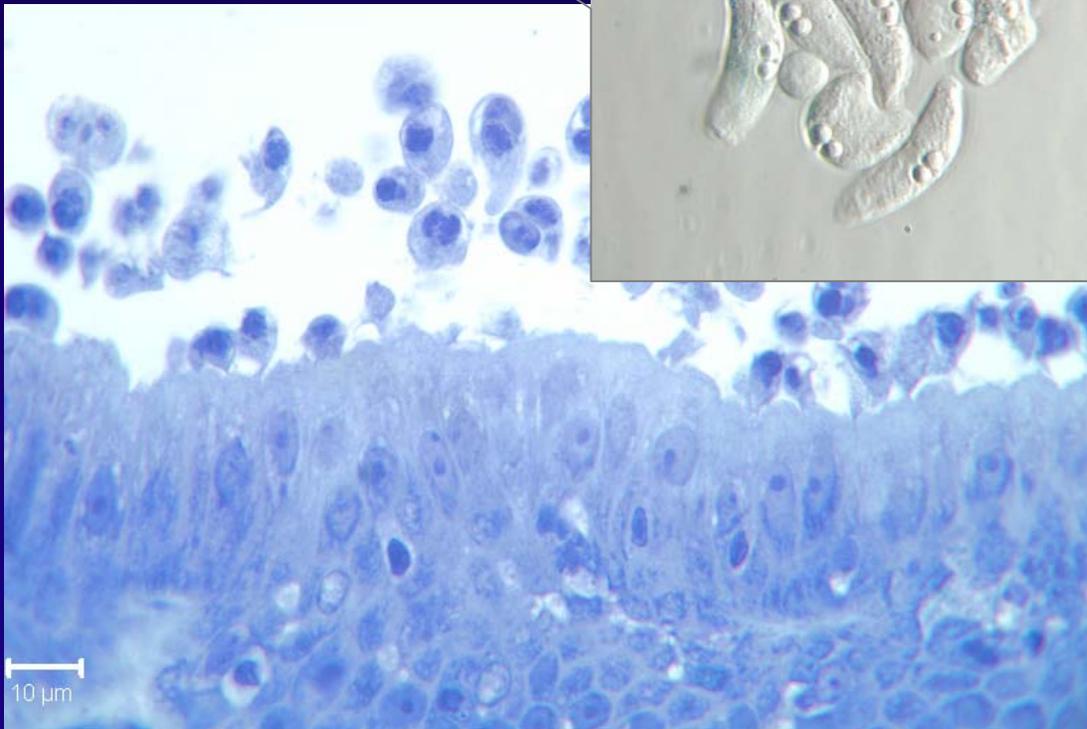
Diamant et al., in press

Skeletal muscle, brain, intestine,  
eyes, swim bladder.



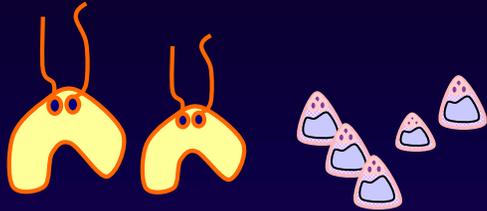
- Recently in Red sea, unknown origin.
- Adult fish (commercial size). Broodstock.
- Low mortality
- Reduced market value
- Increasing incidence

# *Ceratomyxa* spp. (myxozoa)



- Gall bladder of *D.labrax*, *S.aurata*, *D.dentex*, Mugilidae and sparidae: *C. diplodae*, *C. labracis* & *C. sparusaurati*
- Very prevalent in all kinds of culture systems
- Similar effects in all species
- Secondary pathogen, common in mixed infections.

# Knowledge for prevention and control



Host-parasite relationship



**Parasite strategy**  
Life cycle,  
pathogenic action

**Fish strategy**  
Immune response,  
barriers & defenses



**prophylaxis  
control**

**modulation  
selection**