XII Tapeworms

A. Life-cycle

1. Adults in vertebrates
   a. In intestinal lumen
   b. This stage is benign (commensal)

2. First intermediate host
   a. Often an invertebrate
   b. Sometimes called Plerocercoid sometimes a Cysticercoid

3. Second intermediate host
   a. Encysts in body tissues of prey item
   b. Metacestode state
   c. Can destroy organs etc increasing likelihood of host being eaten by final host

B. Spirometra mansonoides

1. Life-cycle
   a. First intermediate host is a copepod (aquatic crustacean, member of zooplankton)
   b. Second intermediate host
      (1) Metacestode called a Plerocercoid
      (2) Infects all classes of vertebrates except fish
      (3) Common in snakes
      (4) Usually lab mice used in experiments
      (5) Occasionally reported in humans = SPARGANOSIS
   c. Definitive hosts
      (1) Dogs
      (2) Cats
      (3) Raccoons


1. Infected mice did not eat more than uninfected mice
2. Infected mice converted food calories to weight gain more effectively
3. Plerocercoid growth factor (PGF)
   a. Produced by plerocercoid
   b. Effects similar to human growth hormone (=hGH)
      (1) Peptide hormone released from anterior pituitary gland
      (2). Characteristics of hGH
         (a) Stimulate synthesis/secretion of other hormones which stimulate muscle, bone growth
         (b) Metabolic regulator of carbohydrate utilization (Counteracts insulin)
   c. When blood plasma of infected mice was injected into non-infected mice, growth was stimulated in non-infected mice
   d. Binds at hGH receptors, not insulin receptors on fat cells
4. Selective advantage to tapeworm of PGF
a. Hormonal perturbation could suppress ability of immune system to
destroy plerocercoid
b. Large intermediate hosts could be more easily spotted and
consumed by final hosts

5. Example of “Be careful of what you say”
   a. In 1990 Phares claimed that the tapeworm had acquired the gene
      for growth hormone from its host
         (1). Would have meant that a gene had “jumped” phyla
         (2). Thought that a virus had been the vehicle for the
            translocation
   b. Not supported by further research
      (1) Partial amino acid sequence was obtained for PGF
      (2) No homology with human GH or other hormones
      (3) Shared 40-50% homology with cysteine proteinases
      (4) Addition of cysteine proteinase inhibitors also inhibited
          receptor binding of PGF
      (5) Located on surface of plerocercoid
   c. The hGH mimic turned out to be a proteinase located on the
      surface of the larval tapeworm

6. Functions of molecular mimic
   a. Facilitates burrowing into extracellular collagen
   b. Sloughing off of the outer covering when plerocercoid eaten by
      final host
   c. Counteract host immune system
      1) Inactivating complement (This has not been shown)
      2) Remove molecules of IgG attached to parasite's surface
         (Demonstrated)
   d. Shows similarities to metastasizing cancer cells

7. Example that helps explain how big “jumps” can occur in evolution
   a. One parasite gene (for a proteinase) increases chances that the
      parasite will get to next host (Protects parasite by destroying host's
      antibodies)
   b. By chance, this molecule binds to GH receptors on host cells (A
      side-effect)
   c. Most side-effects are either detrimental or have no impact upon
      survival, but this one increases the probability even more that
      parasite will get to the next stage of the life-cycle. (Big
      intermediate hosts more likely to be eaten)
   d. Natural selection, now works on two aspects (probably two
      different regions) of the same molecule

D. Human specific tapeworms
   1. Taenia saginata
      a. “Beef tapeworm”
      b. 5-10 meters long
      c. Humans only definitive host known
      d. Intermediate hosts are cattle (Cysticerci cause “measly beef”)
2  *Taenia solium*
   a  “Pork tapeworm”
   b  Common in Middle East, Europe, & Mexico
   c  CYSTICERCOSIS
      (1) Cysticerci or “bladder worms” form in muscles and body organs (Does occur in humans)
      (2) Each cysticercus contains many potential adults
      (3) When cysticercus is eaten, worms evaginate and attach to wall of small intestine
   d  Humans are only known definitive host
   e  Symptoms
      (1) Adult worms: Induce no symptoms
      (2) Cysticerci can be pathological depending upon location
          (a) Commonly in cerebrum & meninges
          (b) Paralysis and epilepsy
          (c) Most common cause of seizures in Mexico

3  Shed light on human evolution
   a  Background: Archaeological evidence indicates that humans domesticated cattle & pigs about 10,000 years ago
   b  Prediction
      (1) If humans acquired tapeworms from ancestors of tapeworms in modern-day cattle & pigs . .
      (2) Then, DNA sequences of human tapeworms would be . . .
          (a) Most similar to tapeworms of cattle & pigs
          (b) Sequence similarity would be extremely close if tapeworms were acquired after domestication of cattle
   c  Test:
      (2) Compared DNA sequences of 35 tapeworm species
   d  Results
      (1) *T. saginata* was most similar to lion tapeworm
      (2) *T. solium* was most similar to hyena tapeworm
      (3) Diverged from common ancestors between 1.7 million to 170,000 years ago
   e  Conclusions
      (1) Reject hypothesis described in “3b”
      (2) New Hypothesis: Ancestors of modern humans fed upon kills of large African predators
      (3) May have competed with ancestors of hyenas
          (a) Fossil evidence indicates that about 1 million years ago, ancestors of hyenas “. . . changed anatomically as if to compete more avidly for carcasses.” (*Science News* 2001, 159:215)
          (b) Competitor could have been ancestor of humans