desirable symbiont with self glycans in order to protect it!

The notion is that faint recognition of an invader elicits weak defensive responses, against which the parasite possesses counterdefenses (such as enzymes that scavenge toxic host products), and that, with continued survival of the parasite, selective interference is initiated, leading to parasite maturation and the production and shed of infective larvae. More globally, my message is that (1) it may be productive to consider lectin recognition systems as belonging to two major functional classes ('defensive' and 'integrative' in addition to the mechanistically-based C-type, S-type etc., classification, which should stand), and that (2) parasitic exploitation of defensive shortcomings in such a system provided the selective pressure for the origin of immunoglobulin antibodies and the vertebrate lymphoid system.

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The Importance of Updating Epidemiological Data

The importance of food-borne parasitic zoonoses cannot be overemphasized, as reported recently by Murrell *et al.* in *Parasitology Today*[1]. As a result of a session at a meeting at Khon Kaen, Thailand, however, we would like to bring to light an observation that Murrell *et al.* omitted. We reported a decrease in *Clonorchis sinensis* infection among the fish of the Sun Moon Lake in central Taiwan. At the same time, we observed an increase in *Haplorchis* spp infection in the fish of the lake, which was known to be endemic for *C. sinensis* about 15 years ago[2]. In the ensuing discussion, we were pleasantly surprised by statements from some researchers in Thailand (C. Khamboonruang, Chiangmai University; and S. Tesana, Khon Kaen University) and Korea (H.J. Rim, Korea University) that they have also observed similar phenomenon of the decreasing liver fluke, *Opisthorchis viverrini* and *C. sinensis* infection in fish, in their respective countries.

Our data showed that of the 4223 metacercariae from a total of 11443 metacercariae collected by artificial gastric juice digestion of 45 freshwater fish, *Hemiculter leucisculus*, from the Sun Moon Lake in October 1995, 4061 (96.23%) were *Haplorchis taichui*, 90 (2.13%) *H. pumilio*, two (0.05%) *C. sinensis*, and the remaining 67 (1.59%) could not be identified because the metacercariae were not fully developed. The two *C. sinensis* metacercariae were obtained from two of the 45 fish examined. In a bimonthly follow-up parasitological survey of 100 fish, we found that the prevalence of *C. sinensis* was less than 0.15% of the metacercariae examined. However, the prevalence of *Haplorchis* spp remained greater than 95%.

These results are in contrast to the report by Wang *et al.*[3] more than a decade ago, in which 100 fish examined from the Sun Moon Lake were all positive for *C. sinensis*. Possible reasons for this decline in the prevalence of *C. sinensis* metacercariae are: (1) the disappearance of pig farms around the lake; (2) increased awareness of the trematode by the lakeside inhabitants; and (3) probably the exclusive use of mammals as its definitive host by *C. sinensis*, while *Haplorchis* spp use birds as well as mammals as definitive hosts.

These results demonstrated the need to update epidemiological data every so often, so as to reflect the contemporary status of the parasitic infection. This brings us to question: can we really believe in the epidemiological figures that appear to be quoted again and again after more than a decade? Finally, we would like to suggest that co-ordinators of future international meetings report similar phenomena that have been observed in different countries, because it is only at such meetings that such information can be obtained and this may reflect the global trend or perhaps the evolutionary course in which the parasite is heading.

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Bovine *Neospora* and *Neospora caninum*: One and the Same

During the past decade, the cyst-forming coccidian parasite *Neospora caninum* has been recognized as a cause of neuromuscular disorders in dogs. Furthermore, *Neospora*-like organisms have been shown to be a major cause of abortion in cattle, worldwide. Until 1988, the parasite was misdiagnosed as *Toxoplasma gondii*.

Neospora caninum has a wide host range and also produces mortality in sheep, goats, horses and deer[1]. It has been suggested that *Neospora* in dogs and cattle may not be the same species[2]. Until recently there were four known canine isolates of *N. caninum* (NC-1–3 and NC-Liv) and five bovine *Neospora* isolates (BPA 1–5). All but NC-1 to NC-liv were isolated in the USA.

It has previously been shown that the two species *N. caninum* and *T. gondii* are phylogenetically very closely related, based on the high degree of sequence homology between their 16S-like ribosomal RNA (rRNA)[3,4]. 16S-like rRNA has been the molecule of choice to study phylogenetic relationships because it is the most slowly evolving of the rRNA genes and it has an adequate size. When comparing *Neospora* isolates (bovine as well as canine) originating from the USA, no relevant differences were found when aligning their respective 16S-like rRNA sequences[5].

Recently, we have isolated *Neospora* organisms from a stillborn calf in Sweden[6]. The isolate has been designated NC-SweB1. Characterization of the isolate has included sequence analysis of the 16S-like rRNA and the internal transcribed spacer 1 (ITS1) as well as electron microscopy and protein analysis. No differences were recorded with this bovine isolate and *N. caninum* NC-1. Previously we have not found any differences in the ITS1 sequences between the two canine isolates NC-1 and NC-Liv[7]. In the ITS1 a large number of sequence differences exist between *N. caninum* and *T. gondii*. This does not contradict the previously demonstrated close phylogenetic relationship between *N. caninum* and *T. gondii*, as the ITS1 is more variable than individual rRNA genes. However, within species the ITS1 is considered to be conserved[8].

Jardine[2] argued that there are no ultrastructural morphological criteria differentiating *N. caninum* in dogs from the *Neospora*-like protozoan of cattle. Furthermore, since no sequence differences have been recorded between *Neospora* isolates of bovine and canine origin, for the future we would like to suggest that bovine *Neospora* is referred to as *N. caninum* until other evidence is presented.

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Book Reviews

Molecular Approaches to Parasitology

edited by J.C. Boothroyd and R. Komuniecki, Wiley–Liss, 1995. £49.95 (560 pages) ISBN 047 1103 41 1

Molecular Approaches to Parasitology is a collection of chapters by the teaching participants in the Biology of Parasitism course held each summer at Woods Hole at the Marine Biological Laboratories (MBL). Now in its 16th year, the course has attracted top students from the US and other countries and has become an important introduction for young scientists interested in beginning a career in Parasitology. The volume, *MBL Lectures in Biology, Vol. 12* is an update of a previous volume of chapters by participants in the course edited by Englund and Sher in 1988. The book covers a broad range of parasites from the viewpoint of how molecular techniques can be applied to increase our understanding of these complex pathogens. The editors intended that the authors describe the projects ongoing in their laboratories, including obstacles and advances, and discuss the field from their personal viewpoints, rather than giving an impartial overview. Most authors adhered to this format and, as a result, the volume is practical and relevant.

The book is divided into six sections: 'Host–parasite interactions', 'Metabolism and drug action', 'Genomes', 'Gene expression and genetics', 'Cell biology' and 'Immune response'. Host–parasite interactions should be the nuts and bolts of any parasitology course, as this is where students learn about the ingenious and unique mechanisms parasites have devised to counteract the hostile environment of the host and also pathogenesis. Information at the molecular level is rapidly being produced in both these areas. Lymphoproliferation caused by *Theileria* is a prime example, and Carrington gives an excellent description of this system, mentioning all the difficulties that arise in sorting out the causes and effects of proliferation, and analyzing the new data on the role of IL-2 and other cytokines in this system.

One would hope that drug development would feature prominently in any course on parasites. The increasing number of parasitic diseases for which there is no effective treatment, due largely to drug resistance, adds renewed impetus to this endeavor. The possibility of developing new therapies for long neglected diseases is one reason many students are attracted to Parasitology. However, there were only three chapters in this section, and although informative, this reflects a limited interest in this aspect. The editors introduce the section by saying that there are two general routes to identify new drugs and one is exemplified by ivermectin which was discovered by random drug screening, and the target identified subsequently. The chapter by Rohrer and Schaeffer from Merck Laboratories gives a clear outline of this story. The other route is to define a target and then design a drug to fit. This is the approach discussed by Ullman and Allen who have focused on hypoxanthine-guanine phosphoribosyltransferase in a number of parasites. In the new era of combinatorial chemistry, this is now the favored approach and may be given more emphasis in future courses.

The 'Genome' and 'Gene expression' sections contain many of the topics that parasitologists have 'grown up on', such as kinetoplast DNA replication, gene expression in *Trypanosoma brucei*, and RNA editing, as well as some refreshing new areas. Joan Feagin describes the progress that has been made in characterizing the extrachromosomal genomes of *Plasmodium*. As Feagin mentions, the hope is that these genomes, which appear to be mitochondrial and plastid in origin, utilize polymerases that differ significantly from the host and can therefore be inhibited differentially by drugs. Wirth summarizes well the difficulties and developments in plasmodial transfection systems, which promise to answer many key questions in drug resistance, and perhaps provide insights into even more intractable problems such as invasion and cytoadherence.

The cell biology of parasites can be used to introduce the important subjects such as life cycles, invasion, intracellular survival and escape, as well as the more classic topics of cell biology such as intracellular targeting and organelle function. The chapters adequately cover both these areas. Dubremetz gives a brief description of the cell biology of *Toxoplasma gondii*, highlighting some of the features relevant to all Apicomplexans, such as the origin of the parasitophorous vacuole membrane (PVM), although he gives very few hints on how to tackle these questions. *Toxoplasma* is probably the most suitable organism to examine the function of the apical organelles, rhoptries, micronemes and dense granules and their contribution to invasion and formation of the PVM. One aspect of parasites that attracts cell biologists is the unusual organelles present, and the chapters by Johnson and Wang on hydrogenosomes and glycosomes, respectively, will be of interest.

Understanding the host's immune response to an invading pathogen lays some of the groundwork for designing vaccines. For some parasites, this has been easier than others. Sher gives a useful summary of T-cell-mediated immunity in several different parasites. Locksley and Reiner describe the results of their studies on the immune response to *Leishmania* and the contribution of this system to understanding basic tenets of the immune system. Except for a brief mention of schistosome vaccine (Pearce), a major omission in this section is an in depth discussion of the steps necessary to develop a parasite vaccine. Bringing potential drugs/vaccines to clinical use is a challenge often not successful, but students need to be exposed to this methodology as well as to basic research. The MBL course attracts many students from developing countries where parasitic diseases are endemic. For these students, discovery and application of new therapies is the first and only priority.

Except for the notable absence of any chapters on molecular development of vaccines the experimental systems discussed are for the most part relevant and useful. The text will be of interest to students who intend to take the course in the future and those intending to choose a laboratory for graduate or post-doctoral work.

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