THE PARASITOLOGICAL SOCIETY OF SOUTHERN AFRICA

The following are abstracts of papers presented at the Annual Scientific Meeting on 26-30 August 1991. The international congress was held in the Kruger National Park and the theme was "Parasitology of Wildlife".

DIE PARASITOLOGIESE VERENIGING VAN SUIDELIKE AFRIKA

Die volgende is uittreksels van referate wat gedurende die Jaarlikse Wetenskaplike Vergadering op 26-30 Augustus 1991 gelewer is. Die internasionale kongres was in die Krugerwildtuin en die tema was "Parasitology of Wildlife".

Serologic survey for selected microbial pathogens in African Wild Dogs (*Lycaon pictus*) and sympatric domestic dogs (*Canis familiaris*) in Maasai Mara, Kenya

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A serosurvey of antibodies to canine parvovirus (CPV), canine distemper virus (CDV), and *Ehrlichia canis* (EC) in African wild dogs and sympatric domestic canids was conducted in the Maasai Mara, Kenya in 1989 and 1990. Samples were collected from about 20% of the sympatric and wild dog populations. Of the domestic dogs, 25,4%, 1,8% and 15,5% were seropositive to CPV, CDV and EC, respectively. The seroprevalence of these 3 diseases in African Wild Dogs was 6,7%, 0% and 0%, respectively. The seroprevalence of CPV was significantly higher (P<0,05) in domestic dogs than African Wild Dogs. Additionally, significant differences in CPV prevalence in domestic dogs were noted between sampling sites (p=0,0013) and years (P<0,001). Differences in seroprevalence of CDV between species were not significant (P= 1,0). The seroprevalence of EC was higher in domestic dogs than African Wild Dogs (P=0,13). The higher prevalence of antibodies to the 3 agents in domestic dogs indicates that domestic dogs may serve as a source of infection for African Wild Dogs.

Antelope as hosts of the common nematode species of sheep and goats in South Africa

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Game farming has grown in importance in South Africa, and pastures are often shared by game and domestic ruminants. In areas where the numbers of antelope species have diminished, there has been a tendency by farmers to introduce more game, even though in many instances this is not being done primarily for financial gain.

It is thus an important question whether antelope are susceptible to the common nematode species of sheep and goats, and whether these worms can be maintained in game in the absence of the domestic ruminants.

From field surveys and experimental transmission of helminths between antelope and small stock in the laboratory it seems that, amongst others, the following nematode species are often shared by sheep and goats and the more common grazers among the antelope, such as blesbok (*Damaliscus dorcas phillipsi*), springbok (*Antidorcas marsupialis*) and reedbuck (*Redunca* spp.); a mixed feeder, impala (*Aepyceros melampus*); as well as a small browsing antelope, the common duiker (*Sylvicapra grimmia*): *Haemonchus contortus, Trichostrongylus colubriformis, Trichostrongylus falculatus, Strongyloides papillosus, Gaigeria pachyscelis* and *Oesophagostomum columbianum.*

Thus, game may be important in the field, as reservoirs of many of the common nematodes of sheep and goats.

The gastro-intestinal parasites of the baboon, *Papio cynocephalus ursinus*, in the Namib Desert

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Freshly collected scat samples from an isolated troop of Chacma baboons, *Papio cynocephalus ursinus*, living in the Kuiseb River canyon in the central Namib desert, have been analysed for cysts, eggs and larvae of gastro-intestinal parasites. Thirteen species have been identified, 10 Protozoa and 3 helminths, all Nematoda. In terms of species diversity, this is thus a protozoan-dominated assemblage which is in contrast to the helminth-dominated ones in the same host in better-watered parts of Africa. With 2 exceptions, the Protozoa form a community apparently the same as that known in man. Most are common with prevalence rates > 40 % . One nematode species, *Streptopharagus pigmentatus*, was common while the other 2, a hookworm and a species of *Strongyloides*, were rare. How do these parasites survive in the harsh desert environment?

Protozoans are considered transmissible as cysts directly via the hand-to-mouth route and therefore bypass any prolonged exposure to the environment. The most common nematode, *S. pigmentatus*, has an insect intermediate host and presumably enters its final hosts with these when they are eaten. Strongyle survival is more difficult to explain but data are presented to show that the soil temperatures at 2 cm depth in shade are suitable for embryonic and larval development but that moisture levels are likely to be too low. Two scenarios for hookworm transmission are suggested; (i) in and around water-holes where the soil will remain sufficiently moist for long enough to allow completion of the hookworms' free-living phase (this may be complicated by the high conductivity of the water, presumably including interstitial water, interfering with the osmotically-controlled egg-hatching mechanism); (ii) hypobiosis followed by vertical or trans-mammary transmission from females (only females were found infected) to their offspring but with a high infant mortality rate keeping the prevalence low. *Strongyloides* transmission is even more problematic but it is possible that this could occur through sexual contact.

Bothriocephalus acheilognathi Yamaguti, 1934, an invasive fish parasite in South Africa

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Bothriocephalus acheilognathi was originally described by Yamaguti in 1934 on material from the intestine of *Acheilognathus rhombea* from Lake Ogura in Japan. Since then this parasite has spread worldwide via the introduction of exotic cyprinids for the purpose of aquaculture. This tapeworm was first recorded in South Africa in the common carp, *Cyprinus carpio*, from the Lowveld Fisheries Research Station in the Transvaal. From then onwards this parasite has been found in various indigenous as well as introduced fish species in various dams and rivers in the Orange, Vaal and Limpopo River systems as well as at Umtata in the Transkei. In the Orange Free State, *B. acheilognathi* occurs mainly in the Smallmouth yellowfish, *Barbus aeneus*. A seasonal survey showed variation in prevalence and mean intensity of this tapeworm in infected fish populations. Highest prevalence and mean intensity were found in autumn, early winter and early spring, and lowest prevalence and mean intensity in mid-summer. Different age classes of worms were also distinguished, which showed seasonal variation in infected fish populations. An interesting phenomenon, namely destrobilation was found where the worms rejected the strobila until only the scolex and a few segments are left. Destrobilation mainly occurred in late winter and mid-summer.

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Mechanisms of host-tick contact with special reference to *Amblyomma americanum* in beef cattle forage areas

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At least 5 groups of parameters regulate contact between ticks (*Acari: Ixodidae*) and host animals. Group 1 (seasonal effects) and Group 2 (daily effects) comprise abiotic parameters and include daylength, temperature, relative humidity and interactions thereof. Groups 3, 4 and 5 consist of biotic parameters. These pertain to biological processes in ticks (Group 3), such as hunger responses and spatial patterns in aphagous tick populations; biological processes in host animals (Group 4), such as patterns of habitat utilisation by host animals, and interactions between host animals and ticks (Group 5). Host-tick contact is possible when ticks are hungry, when ticks exhibit a positive appetence response, and when ticks and host animals are together in time and space. A descriptive model is proposed to correlate these processes and interactions with the observed behaviour of the host-tick contact system in nature. Emphasis in the model is placed on host activity and differences among host types.

Morphological deviations in trichodinid populations

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Trichodinid ciliophorans are best known as fish ectoparasites, but are found as symbionts associated with a variety of invertebrate and vertebrate hosts. These ciliophorans are unique because of the presence of an adhesive disc in which a ring of interlinking components known as denticles occurs. This adhesive disc, with all its separate components, is very constant for different species which provide accurate features for specific identification. Although various theories have been put forward as to the function of these structures, it has recently been shown that the denticles are analogous to vertebrae in the spinal column of vertebrate animals. During multiplication, the denticle ring is also duplicated. This process initially involves binary fission in which each of the daughter cells has half the number of the denticles. A new denticle ring is then formed with the original number of denticles. The old ring is resorbed in the centre of the disc. Various components of the adhesive disc play a part in this process, which is as yet not fully understood. A characteristic that plays an important part during this, is a band that is present within the striated membrane. SEM studies revealed that this band consists of overlapping plates. When examining natural populations of trichodinids impregnated with silver nitrate, this band is not normally visible. Under certain conditions, however, specimens are found displaying this band. When specimens are maintained under laboratory conditions, it appears that this phenomenon is stimulated. The occurrence of this band, which we refer to as the halo effect, coincides with unexplained morphological deviations, such as an increase in denticle numbers and occurrence of atypical denticle shapes.

The Chimaericolidae (Monogenea) - The enigmatic family

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Chimaericolid Monogenea occur on the gills and associated connective tissue of holocephalan "sharks" (Chimaeriformes), a group of primitive cartilaginous fishes of controversial phylogenetic affinities. While most chimaeriform fishes are known only from the fossil record, there are 6 extant genera of which 3 are parasitised by chimaericolids: *Chimaera* and *Hydrolagus* (Chimaeridae) carry *Chimaericola* spp. and *Callorhinchus* (Callorhinchidae) carry *Callorhynchicola* spp.

The phylogeny of the major monogenean taxa has been a controversial topic for many years. Several proposals have been based primarily on the morphology and arrangement of the haptoral sclerites of the oncomiracidia (larvae). Unfortunately, the larvae from preserved parasites were the only source of material available to these authors and as a result, speculative errors have been perpetrated in the literature. Recently, we had the opportunity to examine living oncomiracidia of *Callorhynchicola multitesticulatus* from *Callorhinchus milii* taken off the coast of New Zealand and newly preserved adult worms from *C. milii* and *C. capensis* from the west coast of South Africa. Thus, the fate of the sclerites from the larval haptor has been traced to the adult configuration.

Our elucidation of the number, shape and arrangement of sclerites has enabled us to move towards a better understanding of the phylogenetic position of the Chimaericolidae with respect to its stem-group position within the Monogenea. The fact that the host taxon is regarded as "primitive" amongst the cartiliginous fishes, is also pertinent.

Cytauxzoon felis, a protozoan parasite of wild and domestic felids in North America

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Cytauxzoon felis is one of several newly-described tick-borne parasites of wildlife in North America. This protozoan parasite was described in Missouri in 1976 as the causative agent of a fatal disease in domestic cats. Bobcats were subsequently reported to be a natural host of *C. felis* and *Dermacentor variabilis* ticks have been shown to vector the organism. Cytauxzoonosis occurs in wild and domestic cats in rural south-central United States where populations of each vertebrate exist concurrently. Sporozoites develop in tick salivary glands from where they are transmitted to cats after several days of tick feeding. The tick stage infects reticulo-endothelial macrophages lining blood vessels. A cycle of schizogony occurs producing a multinucleate syncytium that gives rise to merozoites which then invade circulating erythrocytes. In bobcats, this schizogenous cycle is limited and mild disease occurs unless the animal is immunosuppressed; bobcats become long term carriers of the intraerythrocytic (piroplasm) stage and may serve as reservoirs for the infection of ticks. In domestic cats schizogony is extensive and hypertrophy of infected macrophages rapidly causes vascular occlusion. The cats subsequently die of respiratory failure. Subinoculation of blood containing piroplasms from bobcats to domestic cats results in a persistent parasitaemia, however, these cats are fully susceptible to challenge by tick stages or inoculation of tissues harbouring schizont stages. Although *Cytauxzoon felis* resembles *Theileria* spp. in some aspects of its biology, other evidence supports placement of the organism in a separate taxon.

Developing an anthelmintic for dermal application to cats

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Various anthelmintic formulations, containing different active ingredients alone or in combination, were applied to the skin of cats to assess their safety. The dermal penetration of the active ingredients were confirmed elsewhere in the world by plasma assays and efficacy trials.

After small-scale application on cats with a variety of haircoat colours in an in-house cat colony, some of the formulations were tested in field trials on larger numbers of pedigreed cats of different breeds.

All treatments were applied onto the skin after parting the hair in a spot on the dorsal midline just below the poll. Skin reactions were evaluated at regular intervals after treatment. These varied from no reaction at all, to seborrhoea, to severe dermatitis with transudation. One formulation caused a discolouration of the hair that subsequently grew out of the treated spot.

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Arthropod and helminth parasites of bats in the Kruger National Park

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Ectoparasites were microscopically removed from 418 bats of 36 species in 15 genera. Some 60 species of mites (39 genera) were represented, along with 6 of Argasidae and one of Ixodidae. Insect ectoparasites comprised 6 flea species (Siphonaptera), 5 Cimicidae, 5 Nycteribiidae and 4 Streblidae. Parasite/host associations reflect the specialised lifestyle of bats, with only a few genera of families of bat parasites having member species which utilise non-chiropteran hosts. Mites generally displayed narrow host preferences, frequently limited to a particular genus or even species. Several parasites displayed gross morphological or behavioural adaptations to optimally exploit their hosts, while most species had clear distributional separation upon their host. Parasite assemblages frequently also reflected roosting habitat of the host.

Microscopic examination of the intestines of 98 bats (9 species) yielded 3 species of Trematoda, 4 of Cestoda and 4 of Nematoda. Pentastomes were also found within one rhinolophid bat.

Parasitic intensity, prevalence and geographic distribution within the Kruger Park are discussed.

Tick infestation of baboons (*Papio cynocephalus ursinus*) in the Namib desert

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Chacma baboons (*Papio cynocephalus ursinus*) living in an arid environment in Namibia were found to be heavily infested with ticks. A survey to assess tick numbers was undertaken in the baboons' habitat. It included drag sampling, search for ticks on the sleeping sites and examination of domestic stock that occasionally feed in the study area.

A strong correlation was found between the number of *Rhipicephalus* ticks in an area and the amount of time the baboons had spent therein. The systematics of ticks of the genus *Rhipicephalus* are briefly discussed.

Tick infestations are considered to be the major cause of infant mortalities amongst the baboons which occurred at a rate of 85,7% in the past 4 years. The total number of animals in that troop dropped from 33 to 35 in the period from 1972 to 1979 to 15 individuals at the time of this study.

Life-cycle and host spectrum of the ticks in this arid environment will have to be investigated as well as factors contributing to the present situation.

The establishment of an ovine cerebral endothelial cell line (SBE189) that supports the growth of *Cowdria ruminantium*

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Cowdria ruminantium is an intracellular organism parasitising the vascular endothelial cells of ruminants. Recently, the organism has been successfully cultured in endothelial cells of bovine umbilical cord or other bovine vascular origin.

In an ongoing study to identify more suitable cell lines for the cultivation of the organism, an ovine cerebral vascular endothelial cell (SBE189) was isolated and tested for its ability to support the growth of infective *C. ruminantium* organisms *in vitro*.

A study of the developmental cycle of the organism was done on the SBE189 and E5 (a bovine umbilical cord cell line). Twenty-four hour samples were taken post-infection (p.i.) of cultures. Electron microscopical studies of the 24 h sample showed cells with 2 or 3 membrane-bound organisms. One of the organisms was usually large, pleomorphic and reticulate, whereas the smaller ones had a markedly denser matrix. In the 48 h sample, cells contained larger colonies with a condensed matrix. In the 72 h sample, colonies had almost doubled in size and had retained the same density as the 48 h sample with a few of the organisms within the colonies containing a lesser dense matrix. The 96 h sample showed a mixed population of organisms, from pleomorphic reticulated forms to round reticulated forms containing dark blotches of condensed matrix. The few organisms found in the vacuole of the 120 h sample, were either dense pleomorphic forms or what appeared to be degenerative pleomorphic forms with a dense outer matrix surrounding a vacuole.

The *C. ruminantium* in the SBE189 cells was allowed to infect almost 100% of the cells by placing the flask on a slow horizontal rocker. Eight days p.i. the culture material was injected intravenously into mice, resulting in a 100% mortality within 10 d. The lung smears of mice, killed *in extremis*, proved to contain single organisms or colonies of *C. ruminantium*.

The cell line was found to be highly suitable for the growth of *C. ruminantium* and has been added to the stock of endothelial cells currently in use for the maintenance of *C. ruminantium in vitro*.

Infection of hermit crabs (*Pagurus* spp.) by larvae of *Calliobothrium verticillatum* (Rudolphi, 1819) Van Beneden, 1850 a tetraphyllidean cestode of marine elasmobranchs

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Larval tetraphyllidean cestodes recovered from the anterior midgut caeca in 3 species of marine hermit crabs (*Pagurus pollicaris, P. longicarpis* and *P. acadians*) were identified as *Calliobothrium verticillatum* (Rudolphi, 1819) Van Beneden, 1850, on the basis of scolex morphology. The pyramidal scolex has 4 sessile bothridia and a muscular apical sucker. Each elliptical bothridium has 3 loculi which originate in a muscular pad containing 3 small accessory suckers. Infection with *C. verticillatum* plerocercoids was associated with episodes of increased hermit crab mortality which annually peaked in February and March. Elasmobranchs of the genus *Mustelus* are known to serve as definitive hosts for *C. verticillatum* and hermit crabs routinely make up part of *Mustelus canis* stomach contents. The seasonality of plerocercoid infection-related mortalities in the hermit crab may be related to life cycle interactions between vertebrate and invertebrate hosts.

Evolution theories for eye-frequenting, fruit-piercing and blood-sucking Lepidoptera

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The behaviour and economic importance of fruit-piercing noctuids have been reported in Asia, Africa and elsewhere in the course of the last 100 years. Noctuid eye-frequenters have been known since the last century and additional taxonomic families (pyralids, geometrids, notodontids, sphingids, thyatirids) with the same habits are now known. The discovery of the remarkable blood-sucking noctuids in south east Asia dates back to the 1960's. Thanks to detailed investigations and casual observations on the presence and absence of these behavioural groups in Africa, Asia and Europe, an attempt is made to postulate evolution theories in comparison with normal nectar-feeding moths. However, the taxonomic status, the morphological characteristics, anatomy, biology, geographic distribution, bioclimate and host range, allow one to speculate on the geologically recent development of these lepidopteran groups, particularly with regard to the evolution of the parasite behaviour of eye-frequenting and blood-feeding moths.

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Surveying wild and domestic mammals as hosts of eye-frequenting moths

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Field work in Africa, the Middle East and Asia have yielded interesting results on the parasite-host relationship in eye-frequenting Lepidoptera during the past 40 years. The host range is confined to members of Artiodactyla, Perissodactyla and Proboscidea. However, the knowledge mainly covers domestic Bovidae, Suidae, Camelidae, Equidae and Elephantidae. In addition, interesting records stem from Cervidae mainly observed in Asian zoological gardens.

Despite the longer history of African records of domestic host species, there are only a few cases known in wild animals. It is highly recommended to intensify the field work on eye-frequenters parasitising mammals under natural conditions or in captivity in natural environments.

The ticks of Angola

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A checklist of 6 species of argasid ticks and 42 species of ixodid ticks occurring in Angola is presented with discussion on their identification and distribution. Genera representing the family Argasidae are *Argas* (4 spp.) and *Ornithodoros* (2 spp.). The family Ixodidae is represented by the following genera: *Amblyomma* (9 spp.); *Aponomma* (3 spp.); *Boophilus* (1 sp.); *Cosmiomma* (1 sp.); *Dermacentor* (1 sp.); *Haemaphysalis* (4 spp.); *Hyalomma* (2 spp.); *Ixodes* (1 sp.); *Rhipicentor* (1 sp.), and *Rhipicephalus* (19 spp.).

Cross resistance in cattle to adult ixodid ticks and extracts of ticks

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Naive Jersey calves were repeatedly infested with larvae of *Boophilus decoloratus*, to ensure the development of an acquired resistance. After 3 infestations the hosts were divided into 2 groups and again infested but with adults of *Amblyomma hebraeum* and *Rhipicephalus appendiculatus* respectively. In addition, an immune response was obtained by injecting 2 groups of naive Jersey calves repeatedly with crude nymphal extract of *A. hebraeum* and *R. appendiculatus* respectively. These 2 groups were then cross-challenged with adults of the other species. The mean weights of the engorged females of the challenge species compared with that of females of the same species that fed on naive animals as well as changes in the gamma globulin, served as criteria to determine the existence of resistance and/or cross resistance.

The occurrence of *Haemogregarina (Hepatozoon)* sp. in Nile crocodiles in Zimbabwe

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Blood smears from over 100 wild caught Nile crocodiles of Zimbabwe were examined for parasites. Eighty-five percent of these showed gametocytes resembling *Haemogregarina (Hepatozoon) petitti* (Thiroux). Two forms, the intra-cellular and extra-cellular, were seen, the former being horseshoe-shaped and lying in the cytoplasm of the erythrocyte, the latter being spindle-shaped and stretched out following rupture of the cell and release of the parasite.

Prevalence was slightly higher in female crocodiles than in males; it was lower in young crocodiles, under 1,8 m in length, than in adults and there was an indication of decreasing prevalence in very old crocodiles. No seasonal patterns of prevalence were apparent. There was an unexpected relationship between infection and eosinophilia.

Examinations of liver tissue from infected crocodiles failed to reveal extra-erythrocytic forms of the parasite. *H. petitti* is transmitted by *Glossina* spp. but these flies were absent from some collection sites; there was an indication that the leech *Placobdella multistriata* could be the vector.

Monogenea of wild fishes in Lake Kariba, Zimbabwe

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The parasitological examination of the gills of 6 cichlid species: *Tilapia rendalli rendalli* (Boulenger, 1896), *Oreochromis (Oreochromis) mortimeri* (Trewavas, 1966), *Serranochromis (Sargochromis) codringtonii* (Boulenger 1908), *S. (Serranochromis) macrocephalus* (Boulenger, 1899), *Pharyngochromis darlingi* (Boulenger, 1911), and *Pseudocrenilabrus philander* (M. Weber, 1897) revealed the presence of 12 species of *Cichlidogyrus*. Five were new species.

All these *Cichlidogyrus* have been described or redescribed and compared with other species of the genus. A key of identification of the *Cichlidogyrus* present in Lake Kariba has been worked out and their distribution and abundance among Kariba cichlids have been studied.

The gills of 3 Siluriformes: *Clarias gariepinus* (Burchell, 1822), *Synodontis zambezensis* Peters, 1852 and *Schilbe mystus* (L., 1762) were also examined. Seven species of Monogenea were identified including one new species and one new subspecies.

Limnothrissa miodon (Boulenger, 1906) (Clupeidae) harboured only one Monogenea: *Ancyrocephalus papernai* n.sp. which has been described and compared to related species.

The de-ticking of black rhinoceros (*Diceros bicornis*) prior to translocation

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The use of flumethrin pour-on 1,0% and 0,5% concentrations for the purpose of de-ticking black rhinoceros (*Diceros bicornis*) prior to translocation is reported. Both formulations achieved a high level of efficacy within 8 to 12 h following treatment. The 0,5% formulation was found to be more suitable than the 1,0% for use on the dry, hairless skin of the rhinoceros because the increased dose volume resulted in more rapid spreading.

Increased pathogenicity of *Ehrlichia*-like agents after passage through *Amblyomma hebraeum*

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After being passaged through 3 generations of *Amblyomma hebraeum*, an *Ehrlichia*-like agent isolated from an adult *Hyalomma truncatum* female became more pathogenic and elicited a disease in sheep undistinguishable from heartwater. Cross-immunity between this agent and several stocks of *Cowdria ruminantium* and high levels of antibody elicited by the agent, confirmed its close relationship to *Cowdria*.

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Likewise, an *Ehrlichia*-like agent, isolated from a pool of 3 *Rhipicephalus appendiculatus* adult females, became more pathogenic to sheep after 3 passages through *A. hebraeum*. Subsequent passage generations of infected *A. hebraeum* ticks elicited both an antibody response and immunity against *C. ruminantium* in the sheep on which they had fed.

The nature and extent of host-specificity among polystomatid monogeneans in southern Africa

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Polystomatid parasites of amphibians are known to be very host-specific; to such an extent that the identity of the host usually plays a vital part in identification of the parasite. Various authors, including Bourgat and Salami-Cadoux, 1976, Bourgat, 1977 and Murith, 1982, commented on the strict host specificity of most polystomatids known from Africa.

While conducting studies on amphibian hosts in northern Natal, South Africa, 2 new species of polystomatids were found in a single host species, namely *Ptychadena porosissima*. Out of 26 frogs examined, 11 host individuals were infected with one of the 2 parasite species whereas both parasite species occurred in 5 specimens. This discovery is especially significant as the 2 parasite species belong to different genera, namely *Polystoma* and *Metapolystoma*. This is the first record of 2 different genera of Polystomatidae occurring together in the same host species, and the first record of *Metapolystoma* in South Africa.

The success of infection and development of polystome larvae in tadpoles of natural and substitute hosts was studied experimentally. Polystomes became established in substitute hosts as neotenic, bladder-destined and young bladder parasites, with varying degrees of success.

These findings led us to consider again the factors that may be involved in the determination of host-specificity or, under certain conditions, the lack of it. Parasite-related factors as well as host-related factors are discussed.

The effect of Karoo paralysis tick infestations on the resting metabolic rate of its natural host

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The rock elephant shrew (*Elephantulus myurus*) is the most important host for the immature Karoo paralysis tick (*Ixodes rubicundus*). Adult ticks are known to cause paralysis in a variety of domestic animals and wild ungulates. Nymphs cause paralysis in laboratory rabbits, but even high tick infestations have failed to induce paralysis in elephant shrews. The purpose of this study was to investigate the possible effect of tick infestation on the resting metabolic rate (RMR) of the elephant shrew. When infested with burdens of larvae and nymphs encountered under natural conditions, the RMR of larvae-infested shrews did not differ significantly from that of the control group. Shrews infested with nymphs, however, had a statistically significantly lower RMR than the control animals.

On the fine structure of *Lamproglena clariae* Fryer, 1956 from the Kruger National Park

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Lamproglena clariae is a gill parasite of *Clarias gariepinus*. The parasite attaches to the gillfilament and causes proliferation of host tissue.

The body of the parasite consists of 3 parts i.e. the cephalothorax, the thorax and the abdomen. The cephalothorax bears 6 pairs of appendages of which the maxillae and maxillipedes are modified into claw-like structures and are used for attachment.

One pair of appendages are present on each of the 5 thorax segments. All appendages, but the last pair, are biramous.

The abdomen consists of 3 elongated segments and bears one pair of furcal rami terminally.

Initial malaria trials using *Cercopithecus aethiops pygerythrus* show previous infection of *Entopolypoides macaci*

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Earlier experiments using primates as models for human malaria research have made use of feral animals. Malaria infections in these animals were influenced by concurrent infections with other micro-organisms and especially other blood-borne protozoa. This complicated studies on the pathogenesis of human malaria in primates.

The vervet monkey, *Cercopithecus aethiops pygerythrus*, was investigated as a possible primate model for malaria. A monkey, previously obtained from the northern Transvaal region of South Africa, was used in the investigation and maintained under laboratory conditions. Blood smears taken at the start of the experiment showed no evidence of any blood-borne parasitic disease.

Three weeks post splenectomy, and without any prior parasite inoculation an intraerythrocytic protozoa parasite was noted in peripheral blood smears. This parasite was identified as *Entopolypoides macaci*, a piroplasm previously noted in the blood of splenectomised vervets also captured in northern Transvaal. [Fripp (1987). S.Afr.J. Sci 84: 140]. The infection caused a fall in parasite count but did not completely eliminate the parasite. The parasitaemia disappeared spontaneously 3 months post splenectomy. Haematological and biochemical parameters returned to baseline values one month later. Two months after this, the parasite reappeared. It is unknown whether this represents the natural course of the *E. macaci* infection post splenectomy.

The presence of *E. macaci* is of concern, as no screening test is available at this stage to identify vervet monkeys previously exposed to infection.

Ternidens deminutus - A zoonotic helminth of primates?

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Ternidens deminutus is an intestinal nematode which is widespread in monkeys throughout the Old World, from Africa to Asia. However, as a parasite of humans, it has only been recorded from southern Africa, Mauritius and the Comoros. Of all the countries from which the species has been recorded in humans, the prevalence of *Ternidens* in Zimbabwe is by far the highest. This recorded prevalence in humans may be a false statistic and may reflect misdiagnosis of *Ternidens* as hookworm due to the similarity of the egg, rather than to the absence of the species in other areas.

The present paper reviews our knowledge of *Ternidens* infections and discusses the evidence to support the theory that the infection is zoonotic and that it is harboured by monkeys. There is also a discussion of the role of monkeys as reservoirs of related species of intestinal nematodes such as *Oesophagostomum* spp. and *Strongyloides fuelleborni*.

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Zoonotic potential of Tasmanian wildlife

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Due to its long isolation, the island of Tasmania has many unique features as regards its wildlife even when compared to mainland Australia. Although Tasmania shares with the mainland many animal species, some species long extinct on the mainland have persisted on the island. Tasmania was finally cut off from the mainland by rising sea levels some 12 000 years ago. Before this, the island had been colonised by the aboriginal people who at that stage had not yet, for example, introduced the dingo; an important feature of many mainland areas, especially in relation to hydatid disease.

A number of diseases of animal origin are diagnosed from humans in Tasmania, many of them from domestic and companion animals and most of them introduced with these animals by white settlers over the past 200 or so years.

To date, no detailed analyses have been attempted to assess the overall zoonotic potential of Tasmanian wildlife as a whole.

The present paper presents the results of such an analysis, covering viral, bacterial, protozoal, mycotic and helminthic diseases recorded from a wide range of Tasmanian wildlife and discusses the potential of these animals to transmit the pathogens to humans. This potential of transmission of such diseases to humans is discussed in the light of changing opportunities for transmission.

Tick paralysis induced by the cattle egret tick *Argas (Persicargas) arboreus*

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Investigations with the cattle egret tick *Argas (Persicargas) arboreus* revealed that all investigated wild derived strains collected in colonies of *Bubulcus ibis ibis* in Radium, Lydenburg, Kranskop and Pretoria (South Africa) were capable of inducing paralysis in birds by inoculating a neurotoxin. Investigations on the pathogenesis of this toxicosis in birds caused by *Persicargas* demonstrated that the toxin affects motor and sensory nerves and also influences neuromuscular transmission. Furthermore, the toxin is not located in the cells, but circulates humorally. As the paralysis advanced, there was a blockage of a steadily increasing number of nerve fibres, particularly in those of the rapid conduction type. The functional changes in the cable properties of the peripheral nerves were not manifested morphologically, as completely paralyzed birds showed no ultrastructural lesions or reactions in the function-carrying parenchyma. From salivary glands of larvae a toxic fraction was isolated, that induced paralysis when inoculated subcutaneously. SDS-PAGE resulted in 2 bands with molecular weight of 32 kDa and 60 kDa, indicating that the toxin exists as an oligomer which gel permeation chromatography revealed as molecular weight in the region of 80 - 100 kDa. Analytical iso-electrical focusing showed one band with a pI of 4,5.

The fine structure of *Chonopeltis victori* Avenant-Oldewage, 1991 (Crustacea: Branchiura) from the Kruger National Park

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The piscine ectoparasitic genus *Chonopeltis* is endemic to Africa and comprises 12 described species of which *Chonopeltis victori* from the Olifants River in the Kruger National Park, is the most recent.

During scanning electron microscopical and histological investigations of *C. victori*, several entrenched features and additional structures became apparent. The body surface (especially ventrally) is covered by a variety of denticulated scales ranging from ellipsoidal to fingerlike. Interspersed amongst these scales are minute circular pits as well as numerous sensory setae varying from short spine-like to elongated hair-like structures. In males, the second, third and fourth pair of swimming legs have accessory structures that are used in copulation. These structures include various protrusions covered by scales, spines, setae and cuticular pits as well as a large unornamented copulatory "socket" on leg 3 and a distinctive copulatory "peg" on Leg 4.

Each maxillula is transformed into a large sucking disc, bearing 57 to 61 radiating rows of chitinous supporting rods which are composed of 8 to 14 interlinked chitinous elements. Minute spine-like projections and sensory pits are found between the supporting rods and along the inner margin of the sucking disc ring.

A transmission electron microscopical study of the life cycle of *Cowdria ruminantium* in vitro

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The development of *Cowdria ruminantium* (Welgevonden stock) was studied in E_5 cell cultures by transmission electron microscopy from Day 1 to 5 post inoculation. Tissue culture cells were infected with a synchronised inoculum of *C. ruminantium*.

Single large reticulated organisms or colonies containing a few reticulated organisms were identified on Day 1 post inoculation. On Days 2 and 3, colonies of small reticulated organisms with a more condensed inner structure than the large reticulated forms, were observed. Day 3 colonies were seen containing small reticulated and electron-dense forms. It seemed as though the small reticulated forms were transformed into electron-dense organisms which in turn were transformed into pleomorphic to round reticulated forms. The latter were observed extracellularly and this suggested their release from the colonies. On Day 5 the colonies appeared empty and contained only a few degenerative organisms.

Some lethal avian protozoan diseases of native birds in eastern Australia

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Several avian protozoal diseases which cause mortality in birds of eastern Australia are discussed. *Toxoplasma* infection has been recognised in several species kept in captivity and in one free-flying species. In most cases, the infection seems to cause an acute pneumonitis which also affects some other organs such as spleen and liver. In the lungs there are usually many free, and clumps of, zoites confirmed as *Toxoplasma* by immunoperoxidase staining. *Plasmodium* has been seen most frequently in finches, particularly blue-faced parrot finches, in captivity. It has also been seen at Taronga in skuas in quarantine. Some birds die at the stage of hepatic schizogony, others later with intra-erythrocytic schizogony and pigmented gametogony.

Haemoproteus which causes a frequent seasonal massive skeletal muscle myopathy is observed in wild currawongs in the Sydney area. This pathology is observed in association with large numbers of protozoan megaloschizonts in skeletal, cardiac and gizzard musculature. If the bird survives the acute myopathy, then various stages of pigmented sausage-shaped *Haemoproteus*-like intra-erythrocytic gamonts appear.

Asymptomatic infection with *Leucocytozoon* is seen year round in several species of wild birds. Occasionally massive erythrocytic infection occurs with characteristic large, round, non-pigmented macro- and microgamonts, leading to anaemia and loss of weight.

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Parasites of free-ranging mountain gorillas

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The parasite fauna of mountain gorillas in Rwanda and Zaire was determined from faecal samples (n= 128), post-mortem examinations (n=6), and blood samples (n=5). An anoplocephalid cestode, several strongyle and trichostrongyle species, *Capillaria hepatica*, a pinworm, a louse, *Entamoeba coli*, and *Entamoeba histolytica* were found. Only *E. histolytica* is likely to be of human origin, though human contact is frequent. No haemoparasites were detected. All faecal samples contained strongyloid ova, however, generic identification was not reliable based on morphology. Strongyloid burdens, as estimated by McMaster's egg counting technique, were highly aggregated in the gorilla population, with relatively few animals carrying high loads. Adults, particularly silverbacks, had higher burdens than young animals. Adult gorillas that were habituated to people, had lower loads than nonhabituated gorillas. Diarrhoeic faeces contained lower egg counts than normal faeces, while mucus and blood-covered faeces had the highest egg counts. These data suggest that worm burdens vary with age, human contact, and possibly dominance status, and may contribute to certain disease conditions. However, the faecal egg counts should be interpreted with caution because of the low sample size and because a mixed strongyloid fauna contributed to faecal ova output.

The seasonal abundance of ticks parasitising scrub hares in the Kruger National Park

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The seasonal abundances of the major ixodid tick species recovered off scrub hares are graphically illustrated.

The scrub hares were collected monthly over a 2-year period in the southern portion of the Kruger National Park.

Hyalomma truncatum, a transmitter of Crimean-Congo haemorrhagic fever, was the most abundant species. Three species of *Rhipicephalus* were found, which were, in order of abundance *Rhipicephalus zambeziensis, Rhipicephalus evertsi evertsi* and *Rhipicephalus appendiculatus. R. zambeziensis* is more prominent than *R. appendiculatus* in this portion of the park, due to environmental factors.

Blood parasites of helmeted guineafowls in the Kruger National Park

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Blood smears collected over a 25-month period in the Skukuza area of the Kruger National Park from 114 helmeted guineafowl (*Numida meleagris)* revealed the presence of the following blood parasites: *Leucocytozoon neavei, Haemoproteus pratasi* and *Aegyptianella* sp. In addition, one bird was infected with spirochaetes resembling *Borrellia anserina* and another with an unknown parasite (later identified as immature stages of *H. pratasi*).

Subinoculation into guineafowls and turkeys of 6 blood samples collected on 2 occasions, yielded 6 isolates of *Aegyptianella* sp. and 2 of *Plasmodium circumflexum.*

Light and transmission electron microscopy of an *Aegyptianella* sp. of the helmeted guineafowl

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Isolates of an *Aegyptianella sp.* (Rickettsiales: Anaplasmatacea) from helmeted guineafowl *Numida meleagris* were studied by light and transmission electron microscopy (TEM). Ringshaped forms found by light microscopy resembled those of *A. pullorum*, while irregularly shaped forms were specific for the guineafowl parasite. At TEM level, initial bodies and final forms resembled those of *A. pullorum*, while an intermediate sausage-shaped stage was typical for the guineafowl material. This latter stage represents the irregularly shaped forms seen by light microscopy.

Parasites of captive and farmed crocodiles in South Africa

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Specimens were obtained from crocodiles (mostly *Crocodylus niloticus*) submitted for postmortem examination. The protozoan parasites included a yet unnamed species of *Eimeria* with pitted oocyst walls. Sequestered sporocysts are frequently found in the inflamed intestinal mucosa of *C. niloticus. Hepatozoon pettiti* was observed in wild-caught breeding stock and *Giardia*-like flagellates in an inflamed intestine. The metazoan parasites recovered included: strigeid trematodes provisionally identified as *Pseudoneodiplostomum bifurcatum,* ascaridoids of the genera *Dujardinascaris* and *Hartwichia,* rhabditids in the liver of an African dwarf crocodile *Osteolaemus tetraspis* and pentastomes of the genus *Sebekia* in lungs of wild-caught *C. niloticus.*

Parasites requiring vectors or intermediate hosts tend to be found in wild-caught animals, except where management facilitated contact with intermediate hosts (e.g. feeding freshwater fish).

Population dynamics of the caecal nematode *Trichostrongylus tenuis*, a parasite of red grouse

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Intensive population studies on red grouse and *Trichostrongylus tenuis* have been conducted both in England and Scotland over the past 10 years. Grouse populations exhibit cyclic fluctuations in numbers and large scale crashes in grouse numbers are associated with heavy worm burdens.

Losses of grouse from study areas were associated with intensity of parasite infection. Experimental reductions in parasite burdens consistently increased breeding production and survival of grouse, demonstrating that parasites were a significant factor in the population dynamics of red grouse.

Epidemiological studies on *T. tenuis* show the parasites are aggregated within the grouse population and infection is dependent on density in the preceding year. Modelling shows that field results are sufficient to generate the population cycles observed.

The development of "medicated grit" for large scale treatment of grouse appears to stop population crashes.

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Platyhelminth infections of sympatric *Rana angolensis* and *Rana fuscigula* in southern Africa

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Rana angolensis and *Rana fuscigula* occur sympatrically in a large part of the central interior. They are notably similar in morphology and habitat preferences and our hypothesis was that their platyhelminth endoparasites would be closely similar or identical. Specimens of *R. angolensis* and *R. fuscigula* were collected at several localities, mainly within but also outside the region of sympatry. Eye position, subarticular tubercles on hands, foot webbing and the ratio of head width to tibia length were used to distinguish between the 2 species. All possible locations were examined for the occurrence of platyhelminth endoparasites. Adult platyhelminths were found only in the intestines and uninary systems of the hosts. The intestinal infections comprised of a pseudophyllidean cestode of the genus *Bothriocephalus*, a plagiorchiid trematode, possibly a species of *Plagiorchis* and *Sarumitrema hystatorchis*, a telorchiid species. Only the latter species occurred widely in both host species. The others were recorded from only one of the 2 host species at single localities. Infections of the urinary systems comprised of a polystome Monogean and Gorgoderidae. The polystome occurred only at one locality. One *Gorgoderina* species occurred in the urinary bladders of *R. angolensis* specimens from Bovenste Oog in Transvaal. Another gorgoderid species infected the Wolffian ducts of *R. angolensis* and *R. fuscigula* specimens from Golden Gate and Pitseng in Lesotho and belongs to the genus *Phyllodistomum*. Regarding the trematodes, preliminary results indicate greater differences in parasites between localities than between the host species and this tends to support our hypothesis.

Epidemiology of relapsing fever in northern Namibia

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Relapsing fever in Kavango, northern Namibia, is caused by the spirochaete *Borrelia duttoni* which is transmitted by the Argasid tick *Ornithodoros moubata*, the hut tampan. The latter inhabits the sandy floors of huts. These huts are primitive, consisting of reed or mud walls and a sand floor and most people do not sleep on beds. Most huts (87%) were found to be infested with tampans. A total of 41 huts were investigated in detail and an average of 140 tampans were found per hut. The highest incidence of the disease occurs during the rainy season. Exposure to infected tampans may be promoted by the local habit of frequently changing sleeping quarters out of fear of witchcraft. The custom of moving the whole kraal to a new locality after a death, a practice formerly prevalent in Kavango, has now become obsolete. This habit may have served as a preventive measure against the spread of the spirochaete in that tampans infected with *B. duttoni* were left behind when residents moved home. The prevalence of tampan-transmitted diseases appears to be lower in East Caprivi than in Kavango. In the former territory huts are better constructed, and clay is more often used as building material and as flooring.

The epidemiology of the human disease in this area will only be understood when a survey of feral mammals, mainly rodents, is done to determine the infection rate with *Borrelia* in these animals, and hence their potential as reservoirs of the human disease.

Morphological variation of ciliate *Trichodina pediculus* Ehrbg., 1838

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The ciliate *Trichodina pediculus* Ehrbg., 1838 is a fascinating model for the study of variation. These ciliates, specific ectocommensals (or parasites) of freshwater hydras, also occur on different fish species, and form temporary populations on tadpoles. On each of these hosts they find, without doubt, different conditions. The morphological variation of species was investigated by nested analysis of variance [Kazubski (1991). Acta Protozool., in press].

In the case of *T. pediculus* occurring on hydras, variation between local groups of populations dominates; at the same time, the variation between the populations is on a rather low level. In trichodinas from fishes and tadpoles, variation between populations is very well pronounced as well as the variation between local groups of populations. In ciliates from tadpoles and fishes, seasonal variation may be observed. Some differences in groups of populations from different host species may also by noted, but this question needs more investigation.

Analysis of particular characters shows that variation is found mainly in the metric data, such as dimensions of the cell, adhesive disc and denticulate ring. On the other hand, the number of denticles shows lack of variation and rather great stability. Perhaps this is a specific character of trichodinids, giving the possibility to differentiate and identify the species with great probability.

The helminth parasites of African freshwater fishes

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Until recently, the importance of the helminth parasites of freshwater fishes of Africa was not appreciated. However, with the increased importance of fish as a source of protein and with the increase in fish culture, the significance of parasites as potential pathogens that can cause epidemics and mass mortalities is gradually being recognised.

In 1971 the number of helminth parasites known from freshwater fishes of Africa were 223 different species but by 1991 the number of reported species increased to 452 species comprising 250 monogeneans, 58 digeneans, 58 cestodes, 65 nematodes, 19 acanthocephalans and 2 aspidogastreans. This is probably only a small part of the total number of helminth parasites present, where approximately 2 000 species of freshwater fishes are found. Only few of the commercially important species of fishes have so far been parasitologically examined and certain areas of this vast continent have not yet been investigated. Analysis of what is known about the helminth parasites of freshwater fishes of Africa is presented and discussed.

The helminth parasites of Thomson's and Grant's gazelles in Kenya

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Examination of Thomson's and Grant's gazelles in Kenya revealed the presence of several species of helminth parasites. Two species of nematode parasites, namely *Gazellostrongylus lerouxi* and *Cooperioides antidorca*, belonging to the family Trichostrongylidae, produce pronounced pathology in the gut. *G. lerouxi*, a comparatively large blood-sucking nematode, is found in spectacular nodules, mainly in the wall of the abomasum, and occasionally in cases of severe infections in the wall of the intestine. *C. antidorca*, a much smaller species, is found mainly in smaller nodules in the wall of the intestine. The 2 nematodes have very characteristic morphology as they belong to 2 different subfamilies and in sections can be easily differentiated by their synlophes. The morphology and pathology of these nematodes are presented with the help of light and scanning electron microscopy. Their prevalence, importance and possible modes of transmission are discussed.

Incidences and intensities of infections of other helminth parasites encountered are also presented.

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Survival strategies of snail transmitted Trematoda parasites in the Orange Free State

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The life cycle of a typical Trematoda parasite involves a series of larval stages which develop in one or more intermediate hosts that precede the adult stage. The predominant freshwater snail in the Orange Free State, *Bulinus tropicus* (Krauss, 1848) serves as first intermediate host for several parasitic species.

Parasitological surveys have shown *B. tropicus* to shed a total of 9 different cercariae, thus resulting in 9 different parasitic life cycles. Each of these cycles has one or more characteristics which enables it to survive under favourable and unfavourable conditions. The Orange Free State is known as a semi-arid environment, thus placing a time limit on water dependent stages and a survival phase during dry periods of the year.

It was therefore not only important to identify the various parasites with their parasitic life cycles, but also to investigate the ability of these parasites to survive these changing conditions.

Results showed that mainly 2 hosts were used as second intermediate hosts, viz. larvae or adult *Xenopus laevis laevis* (Daudin, 1802), and *B. tropicus* itself, whereas 3 groups of animals were used as final hosts, viz. birds, mammals and adult *X. laevis laevis*. All of the above have the ability to survive unfavourable conditions, either by estivation, hiding or simply by leaving the area.

In conclusion, during the process of evolution these parasitic species have evolved in such a way as to survive in hosts that offer resistance to unfavourable conditions. Life cycle strategies were formed to limit inter- and intraspecies competition to the minimum in order to ensure maximum distribution and therefore enhance the survival of the species.

Comparison of the development of *Anaplasma marginale* and *Anaplasma ovis* in *Dermacentor andersoni* male ticks that were transferred from infected to susceptible hosts

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The development of *Anaplasma marginale* and *Anaplasma ovis* in male *Dermacentor andersoni* transferred from infected to susceptible hosts (calves for *A. marginale*, sheep for *A. ovis*) was studied and compared with light and electron microscopy. The developmental cycle of the 2 rickettsiae in ticks was similar. Colonies were first observed in midgut epithelial cells and infection persisted in gut colonies throughout the experiment. The first colonies contained one large organism that subsequently gave rise to many reticulated ones that become electron-dense over time. After ticks were transferred to susceptible hosts and began a second feeding, *Anaplasma* were seen in muscle cells on the haemocoel side of the gut basement membrane. At this point the development of the 2 parasites differed. Individual organisms or clusters of *A. ovis* were seen in muscle cells, while *A. marginale* developed into colonies causing these cells to become greatly enlarged. A final site of development was in tick salivary glands. For both species, individual organisms were first seen in acinar cells early during the second feeding, and colonies of *Anaplasma* developed in these cells. Organisms within these colonies were initially electron-lucent but became electron-dense. Multiple colonies were observed within salivary gland cells, and they often contained organisms in varying stages of development.

Tick-transmitted protozoa of wild mammals in North America

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Protozoan parasites of North America that are transmitted by ticks to wildlife will be reviewed, including *Theileria cervi* in deer, *Babesia odocoilei* in deer, *Cytauxzoon felis* in felines, and *Hepatozoon* spp. in small mammals. Many changes have occurred in recent years in both the type and distribution of tick-transmitted diseases in North America. Established diseases have changed in their prevalence while previously undescribed diseases have appeared, impacting on both animal and human health. The origin of more recently described diseases is not well understood. These "new" organisms may have either been accidentally imported into the United States or were established diseases of wildlife that are now being transmitted to man and/or domestic animals in the absence of their normal wildlife hosts. Urbanisation of rural areas has resulted in reduction of wild animal populations, thus ticks feed on available hosts including man and domestic animals. Human mobility, movement of wild and domestic animals, and an increased utilisation of outdoors has created new associations between wildlife and non-wildlife hosts. Current information on these protozoan parasites will be presented, along with their changing impact on various wild and domestic animal populations.

The effect of host behaviour in tick infestation

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Aspects of the behaviour of Angora goats and Merino sheep were investigated in order to account for differences in the infestation densities of 2 paralysis tick species. Both Karoo paralysis (*Ixodes rubicundus*) and brown paralysis ticks (*Rhipicephalus punctatus*) occur in the south-western Orange Free State, where they are almost exclusively limited to well vegetated, hilly terrain. The marked differences observed between the infestation densities of sheep and goats with the 2 paralysis tick species, were related to differences in feeding preferences, spatial distribution, activity patterns and other behavioural attributes of both the host and the tick.

A quantitative study of microorganisms on cyathostomes in Hartmann's mountain zebra

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Nematodes were recovered quantitatively from the ventral colon of a Hartmann's mountain zebra from the Etosha National Park, Namibia. Standard methods of recovery of the nematodes at post-mortem examination and preparation procedures for light, scanning and transmission electron microscopy were employed. Ten cyathostome species were identified and the site of attachment of filamentous micro-organisms determined.

Fifty-three per cent of the total cyathostome population were female and 47% male. Sixty seven per cent of the female and 3% of the male cyathostomes were associated with the micro-organisms. In the females, the micro-organisms were usually associated with the vulvar and anal orifices and with the ventral side of the dorsal ray of the male. Because of the density of the microbes, it was not possible to determine the depth to which these filaments penetrate the vagina and the rectum.

To determine whether these microbes hinder the reproductive capacity of the females, the uteri were examined for eggs. The majority of *Cyathostomum montgomeryi* did not contain eggs but the distal end of the vagina was filled with a cement plug with embedded microbes. In contrast, *Cylicocyclus triramosus* contained eggs despite a dense mass of microbes associated with the vagina and rectum. This suggests that the presence of these microbes may interfere with the reproductive capacity of adult cyathostome females.

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Lesions caused by *Cordophilus sagittus* (v. Linstow, 1907) in free-living kudu *Tragelaphus strepsiceros* (Pallas, 1766).

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The macroscopic and histologic lesions caused by infestation of *Cordophilus sagittus* in 99 free-living kudu in the Kruger National Park, are described. Typical lesions occurred consistently in the heart (proliferative endarteritis, aneurysms and fibrosis), and lungs (proliferative endarteritis and emphysema); they were less consistent in other organs and tissues. The prevalence of the lesions increased with the age of the animal. Less than 2,5% of animals younger than one year were affected, whereas 50%, 75%, 93% and 100% of animals of 1 to 2 years, 2 to 3 years, prime adults, and aged, respectively, were affected. Histologically, microfilariae occurred abundantly in the rich subcutaneous venous plexi of the ears and it is suggested that this is the primary site of transmission of the nematode by (a) blood-sucking insect(s).

Morphological adaptations of *Schistosoma hippopotami* from *Hippopotamus amphibius*

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Schistosoma hippopotami were collected from the right heart chamber and pulmonary arteries of *Hippopotamus amphibius* culled in the Kruger National Park. The pulmonary arterial system is an unusual environment for schistosomes, since most species occur in the venous complexes draining the intestines or bladder, thus emitting their eggs via the urine or faeces of the host. This study was conducted to determine whether *S. hippopotami* displays species specific morphological adaptations in order to retain its position within the pulmonary arterial system and to investigate the possibility of this parasite emitting its eggs via the respiratory tract of its host. Scanning electron microscopy revealed a number of adaptations not associated with species occurring in venous complexes. These are the slender body of the male, the small size of the female in relation to the male, extraordinarily large suckers and an intricately-folded female tegument which interlocks with the spines in the gynaecophoric canal of the male. Although eggs were found in lung tissue of *H. amphibius*, it is presently not possible to establish whether the eggs of this parasite are emitted via the respiratory tract of its host.

Ultrastructure of Trichodinid ciliophorans

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Trichodinid ciliophorans are unique amongst protozoans in that they possess an adhesive disc with complex structures such as an interlinking denticle ring, striated membrane and a border membrane. Two species are found associated with the African clawed toad, *Xenopus laevis laevis*, i.e. *Trichodina xenopodos* inhabiting the urinary bladder and *T. falcilata*, an ectoparasite of tadpoles. The morphology of these 2 species differ significantly as a result of their vastly different habitats. Ultrastructural studies for this group have until recently not been possible due to the problem of maintaining viable infections under laboratory conditions. The particular host in this case provides an ideal model, since we have been able to maintain high infections in both the adult toad as well as on larval *X laevis laevis* for extended periods. With a continuous and almost unlimited supply of material, it is now possible to undertake detailed ultrastructural studies.

T. falcilata displays characteristics similar to other ectoparasitic trichodinids normally associated with piscean hosts. *T. xenopodos*, on the other hand, displays unique characteristics, such as a high number of denticles, a body ornamentation in the form of rectangular blocks of which the specific function is presently being investigated, as well as a simple infundibular apparatus which is in direct contrast to all other endoparasitic species described to date.

Haemosporidia of wild mammals of Africa

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Haemosporidian species are widely distributed in African mammals. Several genera of Haemoproteidae (*Hepatocystis, Nycteria, Polychromophilus, Bioccala, Dionisia, Biguetiella*) are well identified by their morphological characteristics, host range and life cycle. In the family Plasmodiidae the only recognised genus is *Plasmodium*.

Polyparasitism: Infections in the wild are usually monoparasitic, an infected host usually harbours more than one species either of the same or of a different genus.

There is always a dominant species but the other species may remain undetected if the host is not examined over a long period.

Vicariance: This phenomenon is well known for Plasmodiidae of the African murid *Thamnomys rutilans* and the Malagasian lemurs. In the different localities there is a vicariant couple, or 3 species which have undergone some speciation according to the degree of their geographical isolation. In the African murids most strains from different localities of the Congo forest basin were classified as sub-species, and iso-enzyme studies were helpful for establishing their systematic status. In Madagascar, lemurs are also parasitised by a vicariant couple and, occasionally, a third species. Lemur distribution is patchy and differences between known parasites which are geographically separated, show more pronounced differences and have been given specific rank.

Host list: The host list of mammalian Haemosporidia is unique and is comprised mainly of Chiroptera and mammals which evolved during the Eocene period. These include lemurs, primates, dermoptera, scuirids, *Atherus*, tragulids, anomalurids, buffaloes, cephalophes and *Thamnomys*. The archaic groups of mammals include the marsupials, insectivores (except the elephant shrew) and carnivores. This host list supports the hypothesis of an evolutionary explosion of the Haemosporidia during the Eocene and the beginning of the Oligocene.

Factors affecting the preferential sites of attachment of two paralysis ticks to their natural host

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The rock elephant shrew (*Elephantulus myurus*) is an important natural host for both the Karoo (*Ixodes rubicundus*) and brown (*Rhipicephalus punctatus*) paralysis ticks. Although immature Karoo paralysis ticks are more confined in terms of seasonal occurrence when compared to the brown paralysis tick, peak periods in tick abundance for both these species are similar. The purpose of this study was to determine the preferential sites of attachment of larvae and nymphs of both tick species to the elephant shrew, as well as to elucidate the effect of tick inter- and intraspecific competition and host-grooming activity on the sites of attachment. A similarity was found in the sites of attachment of larvae and nymphs of both tick species. Interspecific competition had a major effect on the sites of attachment. No overlap in the body areas groomed by the host and sites of attachment of the ticks was evident.

Flea populations on scrub hares (*Lepus saxatilis*) in the eastern Transvaal Lowveld and the eastern Cape Province

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Ctenocephalides felis damarensis was the most common flea recovered from scrub hares studied in the eastern Transvaal Lowveld and the eastern Cape Province,

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with *Echidnophaga gallinacea* occurring sporadically. *Ctenocephalides felis damarensis* showed a definite seasonal pattern of abundance, with peak numbers being recorded in late winter and spring on scrub hares in the Kruger National Park and in the eastern Cape Province.

Life cycle and pathogenesis in equids of *Strongylus asini* Boulenger, 1920

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Strongylus asini has been recovered from the *Vv. portae* and caecae of horses, donkeys and 2 zebra species. After the third stage larvae penetrate the intestinal wall, they enter the liver via the *V. porta* and tunnel into the parenchyma. Fourth stage larvae are present on Day 54 in the *V. porta*, causing a severe phlebitis and by the ninety fourth day the fourth moult takes place. From Day 97 fifth stages are incorporated in thrombi; endothelialisation takes place with occlusion of some vessels. The first fifth stages return to the gut by 366 d and the developing (pre-patent) period is 450 d. In the zebra, donkey and horse there were rises in the serum B-globulins, y-glutamyl transferase (GGT) and alanine transferase (ALT) and in the donkey there were also increases in the concentrations of alkaline phosphatase (ALP) and eosinophils.

Monogenean parasites of the genus *Macrogyrodactylus* (Gyrodactylidae) occurring on *Clarias gariepinus* (Clariidae) in southern Africa.

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This is a survey to record and describe, where necessary, the monogenean parasites of this fish species in southern Africa. Fish were collected from different localities in South Africa and Namibia using beach seine nets, gill nets and an electric shocker and transported live to the laboratory where they were killed immediately before being examined for monogenean parasites. Parasites, when present, were killed and fixed in 10% formalin. They were either cleared and mounted in glycerine jelly or first stained in Mayer's Carmalum and then mounted in Canada Balsam. Three species of the genus *Macrogyrodactylus*, viz. *M. clarii* Gussiev, 1961 and 2 undescribed species, were identified. This genus is endemic to Africa. Fish infested with these parasites were found to be covered by a copious layer of greyish white mucus. *M. clarii* and one of the undescribed species occurred both on the skin and on the gills while the third species was collected from the skin only.

Further evidence of the biological role of the ruminant dental grooming apparatus

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The hypothesis that the incisor-canine complex of browsing/mixed-feeding ruminants is used for the removal of ectoparasites was experimentally tested [McKenzie (1990). Zool. J. Linn. Soc. 99: 117-128]. Nine impala, *Aepyceros melampus*, were used in the experiment which was conducted at the nature reserve of the Tompi-Seleke Agricultural College in Lebowa. The animals were immobilised using etorphine hydrochloride and the tips of the incisor-canine elements on the left side of the mandible were rounded, using an abrasive dental drillbit. The elements were then adhered together using Scotchbond dentine bonding agent. The resultant stump had the same occlusal outline as the original dental arcade, but was smooth and rounded on its lateral surface in contrast to the intact dental comb on the control side. The animals were released into the 125 ha reserve. After one month the animals were shot as part of a routine culling programme. All animals exhibited increased ectoparasite abundance on the experimental sides of their bodies. Of particular significance was the elevated occurrence of engorged adult female *Boophilus decoloratus*. The results of the experiment constitute proof that the incisor-canine complexes of impala are utilised for the control of ectoparasite infestation. SmithKline Beecham Animal Health are thanked for their support of the project.

The ruminant dental grooming apparatus, radiological and histological correlation with function in the impala *Aepyceros melampus*

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Casual observations have revealed that the anterior dentition of impala and other antelope is loosely imbedded, with the tips of the teeth moveable over a distance of 1,5 to 2,0 mm. The comb-like anterior dentition of impala is utilised extensively for grooming purposes, and it was hypothesised that the looseness of the teeth may be related to the grooming function. A sample of 12 impala mandibles was obtained from Pilanesberg National Park, Bophuthatswana. Six of the incisor-canine (IC) complexes were examined macroscopically, radiographically and histologically, while the remaining 6 were used to determine the alveolar depth relative to total root length. The results were:

1. Wide periodontal spaces, most prominent in the apical region; 2. A loose highly vascular periodontal ligament structure; 3. Well developed trans-septal fibres; and 4. Relatively shallow alveoli, with only approximately two-thirds of the roots included within the alveoli. In no case could looseness be ascribed to pathological changes in the periodontal ligament, cementum or alveolar bone, indicating a functional looseness of the elements of the impala IC complex.

These features suggest that the looseness of the teeth is associated with a see-saw action of the teeth about a fulcrum below the alveolar opening, with the closed resting position of the teeth being maintained by the well-developed trans-septal fibres. It is suggested that the minimal interdental space maintained by this arrangement during grooming assists in the efficient removal of parasites from the pelage by impala.

Trypanosomiasis and the conservation biology of black rhinoceros in Tsavo National Park, Kenya

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The conservation of rhinoceros in Kenya involves the translocation of animals to protected sanctuaries such as the 69 km² sanctuary at Ngulia in Tsavo West. Management of animal health during translocations, especially in terms of trypanosomiasis, has yet to be studied in detail, largely because of the urgency of protecting animals from poaching. As the black rhinoceros is known to be susceptible to infection with *Trypanosoma brucei*, there is a possibility that the stress of translocation will induce health problems that would not normally occur in resident populations. To aid in the development of prudent management practices, we initiated baseline studies on tsetse distribution and trypanosomiasis at Ngulia. The sanctuary has a high population of *Glossina pallidipes*, with smaller populations of *G. brevipalpis* and *G. longipennis*. Infection rates in tsetse are in the order of a few percent, with *T. vivax*, *T. congolense*, *T. simiae*, and *T. brucei* all present. Genetic diversity in the trypanosomes appears to be low with all *T. congolense* isolates belonging to the savannah group.

So far, one experimental rhino has been moved to the sanctuary. He succumbed to a cryptic *T. congolense* infection that was detectable only through xenodiagnosis. The animal lost condition following translocation, possibly for nutritional reasons, but it eventually recovered. Future work will concentrate on various aspects of the susceptibility of rhinoceros to trypanosomes, and the use of trypanocides to manage infections during translocations.

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Bionomics of the host-specific leech *Placobdelloides jaegerskioeldi*, a parasite of *Hippopotamus amphibius*

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Except for the Piscicolidae, host-specificity is rare among leeches. Normally blood-sucking species restrict themselves to members of one vertebrate class but al indications are that the glossiphoniid, *Placobdelloides jaegerskioeldi*, is exclusively dependent on the hippopotamus. The dependence is not only in respect o food but also as a substrate for early post-embryonic development. This species exhibits certain features which enable it to successfully exploit this thick-skinnec amphibious mammal. Amongst others, it is, unlike all other African glossiphoniids, a powerful swimmer; its cropcaeca are so shaped that when gorged wit blood, there is no displacement of the dorso-ventral muscles which would have hampered its swimming ability. Furthermore, it is apparently capable of reachin and leaving the rectum of the host via the anus at will and all post-embryonic stages can tolerate the low pH and oxygen levels inside the rectum for prolonge periods. Circumstantial evidence indicates that mating takes place inside the rectum but that egglaying and embryonic development occur independently of th host.

Identification of some Haematozoa from lions

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Lions harbour various protozoan parasites in their blood. Specific identification of some of these is problematical. We found 3 parasites in bloodsmears from lions (n=22) in the Kruger National Park: a *Hepatozoon* sp., a large piroplasm and a small piroplasm.

All lions harboured gametocytes of a *Hepatozoon* sp. closely resembling *H. canis* in their neutrophils. As no serological test was available, specific identification could not be confirmed. Oocysts of *Hepatozoon* sp. were found in haemolymph smears of 3 *Rhipicephalus appendiculatus* adults, one *Ambyomma hebraeum* adult and one *Amblyomma marmoreum* nymph recovered from some of these lions.

One lion harboured a large piroplasm in its erythrocytes. Could this be *Babesia pantherae* Dennig and Brocklesby, 1972, described from a leopard in Kenya?

All lions harboured a small piroplasm, morphologically indistinguishable from *Babesia felis,* in their erythrocytes. Similar parasites from lions and cheetahs in Tanzania were regarded as *Cytauxzoon (=Theileria) felis* [Averbeck et al. (1990). J. Wildl. Dis. 26: 392-394]. An indirect fluorescent antibody test on the serum of 12 of these lions showed no titre against *B. felis.* After inoculation with blood from an infected lion, a splenectomised cat developed a parasitaemia of 35 %, but showed no overt clinical symptoms, a further indication that the species involved is probably not *B. felis.* However, treatment of the cat with primaquine resulted in a marked drop in parasitaemia, which is consistent with *B. felis* infection. Could this be an undescribed species?

Digenetic trematodan infections of fish hosts in a north-eastern Transvaal impoundment

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The 13 fish species of Middle Letaba Impoundment, Gazankulu, were found infected with no fewer than 8 different metacercariae and one adult trematode. Prevalence, intensity and mean intensity values for *Clinostomum tilapiae, Clinostomum vanderhorsti, Clinostomum complanatum, Diplostomum mashonense, Diplostomum tregenna, Diplostomum ghanense, Harvardia sandgroundi, Hysteromorpha triloba* and *Glossidium pedatum* are discussed. Metacercarial infections are related to piscivorous avian hosts.

Is *Toxocara pteropodis* in Africa?

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Toxocara pteropodis, the ascaridoid nematode of flying-foxes, occurs naturally in all 4 species of *Pteropus* in Australia. In effect, it is a soil-transmitted helminth, where the soil is arboreal rather than terrestrial. Adult fruit-bats become infected seasonally by ingesting eggs when they gather in large communal roosts or camps. Larvae hatch from eggs in the intestine and penetrate the gut wall to reach the liver, where they become dormant. In the female bat they pass to the mammary glands post-partum, to infect the suckling juvenile in its first 3 weeks of life. Adult nematodes develop in the juvenile intestine and eggs appear in faeces as early as 5 weeks after birth. The worms are usually lost within 2 to 3 months, at weaning. Intensive contamination of the camp foliage and branches with infective *Toxocara* eggs ensures their ingestion by bats while grooming.

Originally described from *P. geddiei* in Vanuatu, *T. pteropodis* has been found in various *Pteropus* species from their eastern extremity in the Cook Islands across to India in the West. A very similar, if not identical, nematode has been found in another megachiropteran genus, *Rousettus,* in Burma and the Philippines; it is likely to have a similar life-cycle to that of *T. pteropodis*, even though *Rousettus* generally have a cave-roosting habit.

The genus *Pteropus* extends to Pemba Island, 60 km off the Tanzanian coast, but not onto the African mainland. However, several *Rousettus* species occur in Africa, as do other species of large, tree-roosting megachiropterans, such as *Eidolon helvum* which theoretically should be able to maintain *T. pteropodis.* The finding of this parasite in African fruit-bats will provide fascinating insights into its host-parasite relationships, as well as the evolution and dispersal of both the parasite and its Chiropteran hosts.

Human infections with canine hookworms

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Since the 1920's, canine hookworms have been known to penetrate human skin and sometimes to cause cutaneous *larva migrans.* Occasional reports of adult *Ancylostoma caninum*, the common dog hookworm, in the human intestine, have generally aroused scepticism. Over the last 2 years in north-eastern Australia, not only has this species been confirmed to cause human intestinal infections, but also to induce eosinophilic enteritis. In Townsville, with a population of 120 000, it is estimated that about 100 clinical cases of this potentially serious disease are presented annually to medical practitioners. Cases have been diagnosed as far south as Brisbane, and further afield. Its range seems to be limited only by a lack of awareness among the medical profession, for *A. caninum* occurs in most tropical and temperate regions of the world.

An indirect enzyme-linked immunosorbent assay (ELISA) has been developed to detect antibodies to excretory-secretory and somatic antigens of adult A. *caninum* in human blood; this test has proved positive in 80% of almost 100 patients' sera tested so far. We hypothesise that many people are exposed to the almost ubiquitous infective larvae of this hookworm. Most larvae which penetrate human skin become hypobiotic in skeletal muscle tissue, where they survive indefinitely. Cutaneous *larva migrans* very rarely occurs with this species. In some individuals, larvae occasionally reach the intestine to develop into adults; they are unsuited to the human host, as eggs have never been detected in the faeces of patients (in total, 6 adult worms have now been recovered from the human ileum or colon, either by laparotomy or colonoscopy, from Brisbane and Townsville). In even fewer individuals, hypersensitivity develops to secreted proteins, which manifests as eosinophilic enteritis.

Where other parasites are common, the abdominal pain, diarrhoea and blood eosinophilia caused by this infection may pass unheeded. This no longer applies to

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the affluent White population of Queensland. If our hypothesis is correct, then human hookworms and other helminths which inoculate antigens into human tissues may be responsible for similar diseases.

The epidemiology of the common nematode parasites of sheep grazing on improved pastures in the winter rainfall areas of the Cape

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From autumn through spring, lambs grazing on dry-land lucerne pastures acquire *Nematodirus*, supplanted by *Teladorsagia* and *Trichostrongylus* before weaning. In the summer and early autumn, sheep graze either on cereal or lupin stubble and mean monthly mean temperatures of >20°C and <20 mm of rain per month are the most important ecological features in making pastures safe. Some eggs and infective larvae, however, aestivate in the hot dry summer (December - March) and infect grazing sheep in autumn or winter when the mean temperatures are <20°C and monthly rainfall is >40mm. Lambs develop immunity to *Nematodirus* from 12 weeks of age, *Teladorsagia* is spontaneously expelled on safe pastures, but *Trichostrongylus* survives in sheep.

Intensive grazing (26-36 sheep per ha) of grass legume pastures, spray-irrigated (8mm per ha for 3h, 3 times weekly) in dry periods (November - April) creates a paradise for the free-living stages of *Trichostrongylus, Teladorsagia* and *Haemonchus*. Adult sheep started dying in March with massive mixed infections of 26 819 to 132 973 worms, despite treatment 26-40 d earlier, and suckling lambs died in December, in <27 d with worm burdens ranging from 3 020 to 24 067. *Trichostrongylus* is dominant in August, *Teladorsagia* in January and *Haemonchus* in March or April. These pastures are totally unsuitable for raising lambs. Only if weaners and adult sheep are treated with effective anthelmintics, in January, March, May and August, are these sheep able to survive.

W.R.A. (worm resistance to anthelmintics) is increasing and in future, no sheep will be able to graze these pastures. I see only 2 possible solutions: either successful worm vaccines, or genetic selection of sheep which are resistant to worms.

Ligulosis in the northern Transvaal

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Ligulosis, a condition caused when fish intermediate hosts are infected with the large and robust plerocercoids of *Ligula intestinalis*, is widespread in the northern Transvaal. During a recent investigation four *Barbus* species, viz., *Barbus trimaculatus, B. unitaeniaus, B. bifrenatus and B. toppini* were found to harbour *L. intestinalis* plerocercoids, while *Phalacrocorax africanus, P. carbo* and *Anhinga melanogaster* are involved in the completion of the life cycle. Prevalence, intensity and mean intensity statistics as well as the influence of ligulosis on the relative condition factor and reproductive biology of fish hosts are discussed.

Bothriocephalus acheilognathi (Cestoda: Pseudophyllidea) in a population of common carp *Cyprinus carpio* .

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The infrapopulation structure of *Bothriocephalus acheilognathi* was examined in various age classes of common carp *Cyprinus carpio* collected monthly from October 1985 to November 1986 in Umtata Dam, Transkei. Prevalence of infection was about 4 times greater among young of the year than among older year classes, partly owing to differences in diet, and decreased from 90 per cent in summer to 50 per cent by the following spring.

After being spawned in November, fish were soon infected and gravid worms were present within one month. Initially, most infected young of the year had fewer worms (1-10) compared to yearlings (11-100 worms) but recruitment increased as water temperatures rose and by autumn the majority of infected fish in both age groups had similar high infections (101-1000 worms).

The composition of the parasite infrapopulation varied both with the intensity of infection and seasonally. Low intensity infections were dominated by large, mature worms, but as intensity increased, there was a decrease in the relative number of large worms, perhaps as a result of competition. During winter, low temperatures and reduced feeding activity of the host fish created a less favourable environment for the worms. This was exacerbated by crowding. Consequently, the relative number of large, mature worms was lower during winter and spring than during summer and autumn, particularly in high intensity infections.

Cyfluthrin pour-on as an ectoparasiticide for cattle

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Single and repeated applications of a 1% pour-on formulation of cyfluthrin (Bayocide^R, Bayofly^R) were tested at dosages of 1 to 3 mg/kg against natural tick infestations on cattle at 4 localities in South Africa.

The product was applied along the dorsal midline from the poll to the base of the tail. Flumethrin 1% pour-on (Drastic Deadline^R, Bayticol Pour-on^R) was used as a positive control at some localities.

Adult ticks were counted macroscopically in their predelection sites before, and at regular intervals after treatment. The trial animals were infested with *Amblyomma hebraeum, Boophilus decoloratus, Hyalomma* spp., *Rhipicephalus appendiculatus*, and *Rhipicephalus evertsi evertsi. A. hebraeum* were differentiated on the basis of gender and degree of engorgement, but *Hyalomma* and *Rhipicephalus* spp. on degree of engorgement only. Only those *B. decoloratus* that were engorging and > 5mm were counted.

The effect of enrofloxacin on *Anaplasma marginale* in cattle

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The effect of dosages of 5 to 10 mg/kg of enrofloxacin (Baytril^R), a quinolone antibacterial drug, against induced infections of *Anaplasma marginale* in cattle was evaluated in 3 trials.

In the first 2 trials, the calves were 2- to 4-month-old crate-reared Friesians. The calves in the first trial were splenectomised before infection. The calves in the third trial were of various breeds, at least one year old, and from a part of the country where the *Anaplasma* vector is thought not to occur.

Rectal temperature, microhaematocrit and parasitaemia (in thin, Giemsa-stained blood films) were measured at regular intervals to monitor the infections. Calves were treated when their haematocrits dropped to 20 to 25 % . Oxytetracycline was used as a positive control.

Factors stimulating an appetence response and vertical migration in two paralysis tick species

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The Karoo (*Ixodes rubicundus*) and brown (*Rhipicephalus punctatus*) paralysis ticks are both known to induce paralysis in domestic stock. In order to explain

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certain aspects of the epidemiology of Karoo and brown tick paralysis it is necessary to elucidate factors which may contribute towards tick/host contact. The purpose of this study was to determine the extent of vertical migration and the effect of humidity, temperature, changes in light intensity, radiant heat, host odours and CO_2 on the appetence response of the Karoo and brown paralysis ticks. Vertical migration in the Karoo paralysis tick was more pronounced than in the brown paralysis tick. The most important stimulus which induces an appetence response in the Karoo paralysis tick was a rapid reduction in incident light intensity, followed by radiant heat. Stimuli in the form of CO_2 and host odour were the most important factors stimulating an appetence response in the brown paralysis tick.

The effect of veld-burning on the seasonal abundance of ixodid ticks in the Kruger National Park as determined by drag-sampling

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The effect of a total September veld-burn on the seasonal abundance of ixodid ticks is discussed with reference to a control, unburnt locality in the same landscape zone. Seasonal abundance was determined by monthly drag-sampling of vegetation which favours the collection of immatures.

Results indicate an initial reduction in tick populations which recovered within variable periods depending on species, seasonality and host-relationships. The initial reduction, however, seemed to cause subsequent cyclic population decreases over the 2-year monitoring period. The status of the tick population at the time of the burn and tick/host relationships markedly affected their recovery which, in some cases, led to overcompensation.

Babesia trautmanni infection in a warthog (*Phacochoerus aethiopicus*)

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Babesia spp. in African wildlife have been reported in a number of hosts, which include sable, blue wildebeest, bushbuck, rhinoceros, zebra, various carnivores and rodents. However, only in sable antelope has infection been shown to be associated with significant losses. [McInnes et al. (1991). *Jl S. Afr. vet. Ass.* 62: 28-30].

In domestic pigs, babesiosis due to *Babesia trautmanni* occurs when pigs graze pastures contaminated with ticks. Although the vector has not been identified, it has been speculated that wild pigs or warthogs may be important reservoir hosts. Wild pigs can be experimentally infected with *B. trautmanni*, but only develop subclinical infection.

A male warthog approximately 15 months of age and in a poor condition was found in the Pilanesberg National Park. Examination of blood smears showed the presence of *B. trautmanni*. The animal was heavily infested with *Rhipicephalus simus*, but showed no clinical evidence of anaemia. The haematocrit was 0,51. Necropsy examination showed the presence of a fractured jaw. The spleen was normal and there was no evidence that the *B. trautmanni* infection was responsible for any pathological process. Seven positive titres to *B. trautmanni* were found in 20 warthog serum samples examined by means of the indirect fluorescent antibody test. This is in contrast to 12 blood smears which were all negative. These results suggest that warthogs can act as reservoir hosts of *B. trautmanni*, but that they only develop sub-clinical infection.

Babesia spp. isolated from bighorn sheep in California: molecular and antigenic characterisation

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Intraerythrocytic protozoa, belonging to the genus *Babesia*, were recently identified in freeranging California desert bighorn sheep (*Ovis canadensis nelsoni*). Isolates from experimentally-infected bighorn sheep were successfully passed into mule deer (*Odocoileus hemionus*). Babesial parasites isolated from these infections were grown *in vitro* in microaerophilus stationary phase cultures in mule deer erythrocytes. Subsequently, 2 morphologically distinct forms were segregated and continuously grown in culture. A small *Babesia* (2 x 2 µm) was seen as individual ring, paired or quadruplet forms, either marginally or centrally located in the host erythrocytes. A large babesial parasite (4 x 35 µm) was commonly seen as ring, amoeboid or pyriform in shape and centrally located in the erythrocytes. A third, morphologically distinct piroplasm, isolated from naturally infected, free-ranging California bighorn sheep has also been continuously grown *in vitro*, in bighorn sheep erythrocytes.

This parasite appeared as small pyriforms (1 x 2 µm), anaplasmoid bodies (1 x 1 µm) or elongated band forms (1 x 2,5-4 µm). DNA restriction fragment analysis and antigenic characterisation by immunoblot comparisons were performed on the culture-derived isolates. The results show antigenic and molecular differences among these isolates. In addition, they suggest that the babesial parasites isolated from desert bighorn sheep and mule deer are phenotypically and genotypically distinct from *B. odocoilei* of white-tailed deer (*Odocoileus virginianus*).

Application of DNA hybridisation and the polymerase chain reaction to tick identification

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Ticks are major vectors for animal and human pathogens, and proper identification of field samples is of vital importance. Classical identification techniques depend strongly on morphological characteristics which are not always reliable.

The aim of this study was to evaluate the applicability of molecular biological techniques to tick identification. To this end we developed a method to isolate nucleic acid from a single tick. The DNA was digested with restriction enzymes, size fractionated by agarose gel electrophoresis and transferred to nylon membranes. It was then hybridised to radioactively labelled probes and exposed to X-ray film. The probes used come from the ribosomal genes of *Neurospora crassa*, a lower eukaryote. These probes were chosen because of their high level of conservation. It is also known to contain variable regions interspersed with conserved stretches. One of the most variable regions is flanked by 2 conserved areas. Oligonucleotide primers complementary to the conserved regions were synthesised and used in the polymerase chain reaction (PCR) to amplify the intervening variable region. The PCR products were subjected to electrophoresis on agarose and polycrylamide gels.

Results obtained so far indicate that ticks from the genera *Ixodes* and *Hyalomma* differ markedly in restriction sites in and around their rDNAs, but that the variation within the genus *Ixodes* is small. In all ticks analysed, preliminary PCR results show marked conservation in the size of the intergenic spacer between the small subunit and the 5,8S ribosomal genes.

The influence of temperature on the development and survival of immature *Culex (Culex) theileri* Theobald (Diptera: Culicidae) - a laboratory study

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Culex theileri Theobald, a vector of Rift Valley Fever, is a common mosquito in the Orange Free State. The broad temperature tolerance of this species is

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probably responsible for its wide temporal and geographic distribution and abundance.

The effect of various constant temperatures on the development of laboratory-reared mosquitoes (Group A) and on the progeny of field-acclimatised adults (Group B) was studied. For both groups the optimum development temperature was 27°C and the peak development temperature was 33°C. The thresholds of development were 7,9°C and 6,3°C, while the average development times were 11,9 d and 11,3 d for groups A and B respectively. The highest percentage survival occurred at 27°C for Group A while 21°C - 27°C gave the same survival for Group B. The upper critical limits of development to adulthood were 36°C and 33°C respectively while the lower limits were 15°C (Group A) and 12°C (Group B).

The seasonal abundance of ticks parasitising guineafowls in the Kruger National Park

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The seasonal abundances of the major tick species recovered off guineafowls are graphically illustrated.

Guineafowls were collected monthly over a 2-year period in the southern portion of the Kruger National Park.

Amblyomma hebraeum was the most predominant with *Amblyomma marmoreum* being second in abundance. Both these species are potential transmitters of heartwater and guineafowl proved to be good hosts for the immatures of both species.

An undescribed argasid species was also commonly found on the birds.

SEM morphological study of *Linognathus digitalis* (Kleynhans, 1968) from springbok (*Antidorcas marsupialis*)

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Lice are generally very host specific ectoparasites causing irritation and consequent unthriftiness of their hosts. *Linognathus digitalis* is one of 6 louse species specific to the springbok, and is found occupying an exclusive niche in the interdigital fossae on the feet of the host. Unlike other species of this genus found on the hair of their hosts, *L. digitalis* attaches to the soft tissue in the pouch. A sharp, sclerotised hook and cushion-like structures at the tip of each leg aid attachment by piercing the tissue, and securing a strong grip. Being a very distinctive species, occupying a distinctive niche *L. digitalis* is a sucking louse with exceptionally large spiracles found laterally on the abdomen. A single, anterior indentation, as well as a protruberance bearing 9-12 stout setae, is observed in the vicinity of each spiracle.

Male genitalia are simple, and consist of slightly curved parameres with expanded margins centrally. The posterior part of the genital organ is inversible - eversible, and can be completely withdrawn into the pseudopenis. Two rather stout setae are observed laterally on either side of the genital opening. Female genitalia are well developed, and unlike male genitalia, largely setigerous. Gonopophyses taper towards the apices, and mesal margins diverge to form a groove-like structure medially. The female genitalia are adapted to attach the eggs to the hairs situated anteriorly in the interdigital fossal pouch.

Problems related to species diversity and species identity within the genus *Polystoma* in Africa (Monogenea)

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The genus *Polystoma*, parasitic in anurans, is presently represented in Africa by 27 species. Most of these species occur in West and Central Africa. Only 4 species have been recorded from South Africa. It is often difficult, if not impossible, to distinguish between species within the genus on grounds of adult morphological characteristics alone. The morphological similarity between species causes enormous taxonomic problems. Different systematic approaches, including orthodox, phenetic and cladistic, were compared in an attempt to resolve the taxonomic problems. Data obtained from species descriptions and available type specimens were analysed with the aid of computerised image analysis. Of the morphological characters analysed, the haptoral anchors were the most easily quantifiable. For each species, anchor shape was digitised with a Summagraphix Tablet and PLOTIT software. The resulting discrete Fourier Transformations were processed and classified with the aid of MATLAB and STATISTICA respectively. This procedure is potentially useful for comparing distinguishing structures. Because of the great similarity between the polystomes, problems have been encountered in using a programme such as PAUP, in a phylogenetic study of the group. Results obtained thus far indicate that certain species are easily distinguishable from the rest, but others form "species complexes" with few differences between the included species. Nonetheless, it should be possible to contstruct a key to the genus *Polystoma* in Africa.

Fasciola spp. in wild and domestic ruminants, and transmission thereof via cement drinking troughs

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Of the 3 species of *Fasciola* that occur in wild ruminants, only *Fasciola tragelaphi* has not been recorded in domestic animals. In contrast, *Fasciola gigantica* and *Fasciola hepatica* occur in both, and often cause deaths and other economic losses in livestock worldwide.

While deaths from *F. gigantica* infection have also been described in antelopes, including kudu, eland, wildebeest and hartebeest, there is a paucity of information on outbreaks involving both wildlife and livestock.

Recently an outbreak of *Fasciola gigantica* was encountered in impala (*Aepyceros melampus*), kudu (*Tragelaphus strepsiceros*) and cattle on a farm in the northern Transvaal, where, in the absence of natural open water sources, transmission of the infection occurred via borehole-fed cement drinking troughs, which were infested with the freshwater snail, *Lymnaea natalensis*.

The importance of wildlife in the epidemiology of fascioliasis is briefly reviewed.

Is wildlife important in integrated control of the nematodes of domestic ruminants in South Africa?

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During the past 3 decades the control of helminths has depended very heavily on the use of chemical compounds, to the virtual exclusion of other methods. Consequently, resistant strains have emerged. Already, more than 50% of farms in some regions are affected, and in South Africa there are strains of *Haemonchus* resistant to compounds from 4 of the 5 anthelmintic groups. Thus, methods of integrated control have been developed as an aid to the anthelmintics, by integrating anthelmintic drenching with farming management practices that do not favour worm development.

Practically all the methods of integrated control which have been developed to date are based on pasture spelling, which entails either the resting of pasture until it is safe for susceptible animals, or else alternate grazing of animal hosts that differ in susceptibility to the common parasitic nematodes.

Unfortunately, however, various antelope species are susceptible to the common nematodes of cattle, sheep and goats, such as species of the genera *Haemonchus, Trichostrongylus, Gaigeria, Strongyloides, Bunostomum* and *Oesophagostomum*. Thus, with the tendency to conservation and with wild ruminants now being kept with domestic stock, it is important, when methods of integrated control are recommended to farmers, to consider that game can serve as reservoirs of these helminth species. For instance, *Haemonchus contortus* and/or some of the *Trichostrongylus* spp. may not be controlled satisfactorily if

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blesbok (*Damaliscus dorcas phillipsi*) or impala (*Aepyceros melampus*) graze on pastures from which small stock have been withdrawn temporarily for producing safe grazing for sheep and/or goats. Also, valuable antelope may be lost if they are placed on pasture that has been heavily infected by domestic stock.

The external morphology of the pupae of southern African *Lipoptena* (Diptera: Hippoboscidae)

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The taxonomic significance of the puparia of the various species of hippoboscid flies has not previously been investigated. With the aid of scanning electron microscopy the ultrastructure of the external morphology of the puparium of 3 *Lipoptena* spp. were examined and compared with one another. Indications are that this, together with aspects of adult morphology (some of which have not been considered before), could lead to a critical re-evaluation of the status of southern African *Lipoptena* spp.

The intermediate hosts of *Taenia* spp. of lions in the Republic of South Africa

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In the Republic of South Africa lions are commonly infested with 2 tapeworms, viz. *Taenia regis* (Baer, 1923) and *Taenia gonyamai* (Ortlepp, 1938). In an attempt to identify the intermediate hosts of these cestodes, a morphological examination was carried out on cysticerci which occur in a variety of wild animals.

Cysticerci with rostellar hooks resembling those of *T. regis* have been found adhering to the mesentery or in the liver or lung of blue wildebeest, Burchell's zebra, sable antelope, waterbuck, gemsbok and warthog. The parasites are approximately 1 cm in diameter and on removal of the adventitious layer, the metacestode is about 40 mm long by 5 mm wide with an invaginated scolex at one end. There are 40-49 rostellar hooks arranged in 2 crowns; the large hooks are 223-290 µm and the small ones 128-187 µm in length.

Cysticerci with rostellar hooks resembling those of *T. gonyamai* have been recovered from the muscles of impala, blue wildebeest, buffalo and kudu. Macroscopically these cysticerci resemble those of *Taenia saginata* in cattle but they are armed with 32 to 40 rostellar hooks of which the large are 183-218 µm and the small hooks 120-157 µm long. Such cysticerci from a blue wildebeest were fed to a lioness and gravid proglottids of *T. gonyamai* were found in her faeces 54 d later, thereby confirming the identification of the cysticerci.

The life cycle of *T. regis* has not yet been confirmed experimentally.

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