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COLLABORATIVE INVESTIGATIONS INTO AVIAN MALARIAS: AN INTERNATIONAL RESEARCH PROGRAMME[1]

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About ninety years ago, Danilewsky in the Ukraine and Laveran in Algeria were respectively assembling the first information on the parasites of avian and human malarias. They were unaware of each other's work and Laveran had precedence by a few years. However, it was an avian species of *Plasmodium* that Ross used to achieve the first demonstration of the transmission of malaria in 1897 in India. Almost immediately afterwards, his work was confirmed by a group of Italian investigators, working quite independently. The twentieth century opened with a quite remarkable burst of productive research into the plasmodia of vertebrates.

Initially, many of the researchers were isolated in Afro-Asia, where library facilities were often poor. Working essentially in a vacuum, adhering to the concept of "one host—one parasite", they described new species, frequently from a single film, usually without comparison of their material with that from other regions and without adequate life history studies. Published descriptions of the parasites were frequently inadequate and commonly not illustrated. The basic material from which these species were described is only too often no longer in existence in 1972, when the systematics of the avian hematozoa urgently need clarification—without which we will continue to lack understanding of host - parasite relationships among wild avian populations.

Avian trypanosomes furnish a good example of the prevailing confusion. Of the 100 or so "species" of these flagellates recorded in the literature, most were described without an illustration and many merely on the basis of their demonstration in a new host and/or locality. Studies of life cycles and host specificity were seldom attempted. Such studies of *Trypanosoma avium* Danilewsky have now shown that the parasite is pleomorphic, virtually cosmopolitan and has a wide range of both vertebrate and invertebrate hosts. On present information, no more than five species of avian trypanosomes can be sustained on morphological grounds. Unfortunately, modern compilers of lists of avian hematozoa have perpetuated this confusion by merely citing species names and their avian hosts, without attempt to analyze the validity of descriptions or to clarify the situation. Such evaluations in species lists would alert the researcher to a potential taxonomic problem.

AN INTERNATIONAL REFERENCE CENTRE

The necessity for a reference centre for avian blood parasites is self-evident. Such a centre, the WHO International Reference Centre for Avian Malaria Parasites, was established at the Memorial University of Newfoundland in 1967.

The activities of the Centre are still in their initial phases. A reference series of 35 mm colour slides of some 20 species of *Plasmodium* has been prepared. The first supply was soon exhausted in meeting requests, and a revised set is in preparation. This will include not only a wide range of *Plasmodium* spp., but also

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species of *Leucocytozoon, Trypanosoma* and the haemoproteids.

A card index and bibliography of the literature on avian blood parasites is being assembled, but the actual collection of reprints is still small. Further contributions would be most gratefully received. Ultimately, these holdings will enable the Centre to meet requests for copies of individual items.

In 1970, the first WHO Fellow (from Iran) spent a study period at the Centre, the resources of which are stimulating graduate projects.

The Centre's slide collection already represents some 1050 species of birds (12% of the known species) belonging to 100 families (60% of the known families). The material comprises over 25,000 blood smears of which about 18,000 have one or more blood parasites. The geographical representation of the Centre's collection indicates extensive collections from North America and South East Asia. So far, however, the Centre has little European and Australasian material. As Europe is the source of many of the earlier descriptions of avian hematozoa, contributions from the type hosts and type localities from there and elsewhere would always be welcomed. While relatively little African material is yet on file, collaborators in Tanzania, Uganda and elsewhere are remedying this situation. Similarly, South American material is scanty, although collaborating scientists in Colombia, Trinidad and Brazil have recently contributed valuable collections.

WATERFOWL HEMATOZOA

A study of the blood parasites of ducks and geese of the northeastern seaboard of North America is in progress. Considerable cooperation with wildlife authorities in both Canada and the United States has resulted in the accession of some 8,000 blood films of ducks and geese in 1968-1972. Comparisons of the species of hematozoa and the prevalence of parasitism in ducks and geese from various parts of the world are also under way. To date, the survey has shown that:

i there are no blood parasites in approximately 100 eider ducks from Scotland;

ii babesioids occur in ducks in Tanzania;

iii *Leucocytozoon simondi* occurs in approximately 20% of the ducks and geese from the northeastern seaboard of North America (this parasite, well known in Scandinavia, has also been demonstrated in a mallard duck from Czechoslovakia);

iv *Haemoproteus (Parahaemoproteus) nettionis* occurs in about 50% of anseriforms of North America, but is absent in ducks so far examined from elsewhere;

v *Plasmodium circumflexum* occurs in 10-15% of the ducks of the North American Atlantic seaboard; *Plasmodium relictum* and *P. vaughani* have also been found rarely. No *Plasmodium* spp. have been found from ducks from other areas in our survey to date;

vi the anseriforms of North America appear to be more heavily parasitized with hematozoa than those from any other region;

vii anseriforms breeding in the high tundra are virtually parasite-free, in sharp contrast with those at the northern limit of the tree-line (e.g. Ungava Bay), which show high prevalence of *L. simondi* and *H. nettionis.*

NEWFOUNDLAND SURVEY

A four-year study on the prevalence and seasonal fluctuation of blood parasites in a population of Newfoundland birds was completed in 1972. In this study, nets were set in the same place for each of 4 successive years, all birds being caught, banded, and released, following the taking of blood smears. Some 3,000 birds were involved, of which 700 were recovered once or more in a single year and about 200 recovered once or more in each of 2 years. Some individuals were recaptured weekly over a 10 week period during the summer. This project has provided an experimental wild bird population for studies on: (i) prevalence of parasitism; and (ii) seasonal fluctuation of incidence and prevalence of parasitism correlated with occurrence of vectors, breeding season, behaviour of the avian host, and stress factors such as host migration.

Some preliminary conclusions can be drawn from the data now to hand: 1) There was a high prevalence of blood parasites in the passeriform birds of the Avalon Peninsula, Newfoundland; approximately 90% of the birds surveyed had one or more blood parasites. 2) Certain blood parasites were absent, viz. *Leucocytozoon simondi* of ducks, *L. sakharoffi* of corvids, *Haemoproteus (Parahaemoproteus) velans* of woodpeckers, *H. (P.) nettionis* of ducks and *H. (P.) canachites* of grouse. Members of the genus *Plasmodium* were uncommon, and filarioids were demonstrated only twice. These absences may reflect the insularity of Newfoundland, for the parasites in question are abundant in birds from adjacent mainland areas. 3) There is only one dominant vector within each of the dipterous families Simuliidae and Ceratopogonidae. These flies are the vectors of *Leucocytozoon, Parahaemoproteus,* trypanosomes and some filarioids. 4) Local birds acquired their parasites in Newfoundland, rarely on migration. This was shown by the fact that the young birds of the year (those which have not yet migrated) had the same parasites and the same prevalence of parasitism as did the adults. Non-migratory species had the same parasites and incidence of parasitism as the migratory species. Both young and adult migratory birds returned the following year with the same parasites (or with one or more less) than they had the previous year. No additional parasites have yet been identified from such hosts.

WORLD-WIDE SURVEY OF PASSERIFORMS

The global distribution of some of the common hematozoa of passeriform birds is being studied. A major limitation here is that we are necessarily restricted to identifying these organisms by the morphology of the stages present in blood films. Ideally, the description of new species of blood parasites should include life cycle data (including evidence from tissue and vector stages), periodicity (where it occurs), pathogenicity, etc. In practice, however, most work on avian blood parasites today still concerns only the stages found in the circulation. Recognizing the shortcomings of blood film material, we are here referring to the distribution of "species" defined solely on morphological criteria, in full awareness of the fact that once experimental studies have been undertaken, such organisms may prove to be species complexes with several physiological strains or subspecies. With this reservation, initial examinations of the Centre's collection indicate:

Plasmodium vaughani is cosmopolitan in a wide range of passeriform birds, and occurs in other groups including quails and ducks;

Plasmodium circumflexum is cosmopolitan in a wide range of hosts;

Plasmodium relictum is cosmopolitan in a wide range of hosts;

Haemoproteus (Parahaemoproteus) fringillae occurs in a wide range of hosts and is virtually cosmopolitan;

Leucocytozoon fringillinarum appears to be cosmopolitan in the Passeriformes;

Leucocytozoon dubreuli appears to be cosmopolitan in the Turdidae and their near allies;

Trypanosoma avium is cosmopolitan in a wide range of hosts.

It may well prove that the genera *Plasmodium* and *Leucocytozoon* are cosmopolitan, each containing some 15-25 species. On present evidence, the haemoproteids (which require extensive taxonomic study) appear to be more regional in their distribution, with only a few cosmopolitan species.

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