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ECOLOGICAL RELATIONSHIPS BETWEEN ARBOVIRUSES, ECTOPARASITES AND VERTEBRATES IN ETHIOPIA

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Five topographically and ecologically diverse study sites that on the basis of human serological testing showed the highest antibody rates in Ethiopia were resurveyed in order to identify the natural vertebrate reservoirs and vectors of arboviruses infecting man. From fall 1969 until spring 1977, when personnel associated with NAMRU-5 were evacuated, over 80,000 animals were captured, 16,163 sera were obtained, 48,995 birds were banded for studies of population turnover and movements, and 4,946

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20. vertebrate voucher specimens (3,195 birds, 971 bats, 372 other mammals and 408 reptiles and amphibians) and large numbers of ectoparasites (especially mosquitoes and ticks) were collected.

Of 15,243 serological test results available (13,115 birds, 926 bats, 796 other mammals, 259 reptiles, and 147 amphibians), significant antibody levels were found in 2 species of Agama lizards, 45 species in 22 families of birds, 7 species of fruitbats, 1 insectivorous bat, 2 species of primates, the domestic cat, and 1 rodent; shrews warrant further study. Antibodies to the following viruses were involved: West Nile, Ntaya, Banzi (or Uganda S), Zika, Spondweni and Wesselsbron.

Virus isolation, which had not been completed when the project ended, revealed 30 isolations from wild vertebrates including West Nile, dugbe, Arumowot, Abu Mina and Bunya viruses. Three strains remain unidentified and three others were abandoned in Ethiopia. Germiston virus was isolated from sentinel mice and Congo, Thogoto, dugbe and Jos viruses from ticks.

Table of Contents

Figures

Introduction

Arboviruses are a large and diverse group of almost 400 different agents which are transmitted by the bite of blood sucking arthropods, such as mosquitoes, small biting flies and ticks. Most arboviruses have a natural cycle which involves passage among wild bird and other vertebrate reservoirs by means of vector arthropods, which may also in turn occasionally feed on man and infect him. Of the 400 registered arboviruses, 80 are known to cause human disease, and many of them are transmitted by several vector species. The vertebrate hosts include a broad range of mammals, birds, reptiles and amphibia. Unfortunately, because of the limited geographic distribution of some arboviruses, and the expense of intensive long-term investigations, the natural hosts and infection cycles have not been identified for many of them. Moreover, information derived from studies of one ecosystem may not be applicable to another, where the topography, climate, fauna and flora are quite different. Thus, there is great need for continued work on arbovirus-host-vector relationships, not only to unravel the epidemiological and epizootiological features of the diseases, but also for the practical object of protecting man from infection through control of the important animal-to-man vectors.

Arboviruses pathogenic for man are found in all parts of the world. While some are found only in discrete regions of single continents, others such as West Nile and Congo-Crimean hemorrhagic fever virus, cover areas as broad as Africa, Europe, and Central and Southeast Asia. Migrating birds, and ticks that they carry, have been implicated as responsible for the long distance dissemination of those arboviruses. Particularly vulnerable to infections caused by arboviruses are large contingents of non-indigenous personnel temporarily working on civilian development projects and foreign military personnel conducting operations in the tropical and semitropical rural areas where arthropod vectors may be active much of the year.

For this reason, arbovirus research has involved and should continue to involve long-term field studies aimed at the isolation and identification of agents from arthropod vectors and vertebrate hosts, and from infected humans. One of the goals of such field studies has been to map geographic distribution of the agents, their vectors and their wild hosts.

Ethiopia was chosen as the site for a long-term multidisciplinary arbovirus survey in 1969 because of its past evidence of arbovirus infection, its key location in northeast Africa in a transition zone between the Sahara desert and the sub-Saharan tropics, its ecological and altitudinal diversity and the presence of a well-equipped and well-staffed U. S. Government Naval Medical Research Unit (NAMRU-5). The survey was started under an Office of Naval Research contract with the University of Washington, Seattle and continued after 1971 under another ONR contract with the Smithsonian Institution. Field work and laboratory serology and isolation in Ethiopia lasted until April 1977 when political events forced NAMRU-5 to close and evacuate all personnel, data and specimens within four days. Much vital material was lost or had to be abandoned during the hurried evacuation.

Dr. John S. Ash, an ecologist whose previous experience had been with bird ecology and ectoparasites, headed the field team in Ethiopia, and functioned as head of NAMRU-5's Medical Ecology Division. Other scientists who worked directly on the program were employed by the U. S. Navy and consisted of virologists Drs. Wesley K. Ota, and Owen H. Wood and entomologist Vernon H. Lee.

In May 1977 Dr. Ash was restationed at the Smithsonian Institution in order to prepare for publication the data that he had collected. He in collaboration with Dr. Owen Wood, who was restationed at the Yale Arbovirus Research Unit (YARU) in New Haven, Connecticut, prepared most of this report.

Serologic surveys in humans revealed an extensive arbovirus distribution in Ethiopia, with antibody rates being particularly high in residents of the western lowlands of Ilubabor Province and the valleys of the Didessa, Blue Nile, Awash, and Omo rivers. Antibody patterns point to the presence in these areas of viruses belonging to the A, B, and Bunyamwera groups, and the high rate of plurally-reactive sera suggested that each group may be represented by several agents. Four group B viruses (yellow fever, West Nile, Zika, and Ntaya) had been recovered from animal and arthropod sources in Ethiopia, but isolation studies were not sufficiently intensive to reveal which members of the other two groups were present. However, it was reasonable to expect, by virtue of their prevalance in neighboring countries, that chikungunya, O'nyong-nyong, Sindbis, Ibesha, and Germiston viruses would be endemic in Ethiopia. The presence of such a variety of medically important arboviruses in a limited geographical area afforded an ideal opportunity to extend work on their natural host ranges and to attempt to identify those factors contributing to their maintenance in nature.

The range of illness produced by pathogenic arboviruses is broad, ranging from a mild headache and fever, through a dengue-like illness with severe muscle and joint pain, to death from severe infection of encephalitis or hemorrhagic fever. Dengue and dengue-like viruses can spread very rapidly when mosquito densities are high and outbreaks commonly involve thousands of cases. Encephalitic complications do not reach such high numbers, but demand much more in the way of hospital care. Hemorrhagic disease may not only endanger the patient, but also the medical staff. Blood and body fluids from patients with Crimean hemorrhagic fever have caused hospital outbreaks in which doctors and nurses were infected and subsequently died.

At times wide scale epidemics of arbovirus disease may occur. For example O'Nyong-nyong was implicated as the causative agent in an estimated 5 million cases of dengue-like disease in East and Central Africa during recent years. In September and October of 1977, an estimated 30,000 cases of an active flu-like illness, caused by Rift Valley fever virus, were reported in the east central delta region of Egypt. Complications included hemorrhage, encephalitis and blindness, but with a mortality rate of less than 1%. This outbreak is of particular relevance to large-scale U. S. operations, in that Rift Valley fever virus is highly infectious and rapidly disabling, and there is presently no federally approved vaccine for it.

The recent discovery of highly potent viruses in Africa, such as Lassa and Marburg, emphasize the need for broad surveys in a quest for arboviruses in wild vertebrates in tropical regions.

Objectives and Benefits:

The primary objectives of the arbovirus study in Ethiopia were:

1. To identify the natural vertebrate hosts of arboviruses infecting man in Ethiopia, through:
    a. systematic examination and identification of animal species inhabiting endemic areas;
    b. determination of the immune status of the material collected.
2. To assess the relative importance of naturally infected vertebrates as virus disseminators, through:
    a. estimation of population densities;
    b. determination of attractiveness to arthropods of hosts known to be naturally infected;

c. estimation of population "turnover" rates and their significance in providing a continual pool of susceptibles;

d. determination of the level and duration of viremias resulting from peripheral inoculation of virus.

Resulting from 1a and 1b are presented in this report; results from 2a, 2b, and 2c are referred to in this report but await analysis; field research involved in 2d was not completed because of the premature termination of the project. The great bulk of the material collected for virus isolation from wild vertebrates was not yet processed before it had to be abandoned in Ethiopia. Similary the results from nearly 1000 sera were also lost.

Secondary benefits deriving from the work included:

1. Information on the geographic distribution of mammals, birds, amphibia and reptiles in Ethiopia.
2. Data on animal dispersal and migration, feeding habits, behavior towards traps, and the localization and characterization of microhabitats.
3. Information on the influence of climatic conditions, altitude and vegetation on animal distribution.
4. Identification of ectoparasites infesting animals.

Much of the data collected under these headings has been published (see bibliography).

Review of Literature on Arboviruses in Africa

To determine what arboviruses are present in an area one can either try to isolate the viruses or look for antibody to them. Virus isolation unequivocally establishes the presence of a virus in a locality, but says little by itself concerning the threat of virus disease or infection. Antibody on the other hand establishes that infection has taken place but the questions of where and when have to be determined by epidemiologic methods. In the case of group B arbovirus (flaviviruses) even antibody may not be completely specific and one may still need virus isolations to pinpoint the infecting agent. Antibody studies or serologic surveys are quick and inexpensive compared with virus isolation provided they can give the answers desired. However, one can of course test for antibody only when one has the antigen in hand and one cannot expect to discover new viruses in this fashion. For this reason in considering the literature of African arboviruses isolation data is mentioned along with serologic survey data just as virus isolations were carried out as part of the serologic study reported below. The following review of the literature on African arboviruses is incomplete, but covers the main points of significance.

Serologic surveys for arbovirus antibody in Africa have been carried out since 1927. Early surveys attempted to delineate the extent of yellow fever. Virus neutralization testing in rhesus monkeys and later in mice was the principle testing method. Although the complement-fixation (CF) test was available, it was felt that the CF antibodies did not persist long enough after infection to make the test useful as a survey test. The development of the hemagglutination-inhibition (HI) test in 1958 greatly extended the numbers of sera that could be surveyed by reducing testing time from 14 days to 2 days. At the same time the HI test offered as good retrospective characteristics as the neutralization test.

In the course of yellow fever investigations, numerous other arboviruses were discovered. A program to assess the public health importance of these agents was initiated by The Rockfeller Foundation in 1951. Through this program substantial support was given to three African laboratories in Ibadan, Nigeria; Johannesburg, South Africa; and Entebbe, Uganda. The Institute Pasteur supported several laboratories in the French-speaking areas of Africa and in Ethiopia. The principal laboratory of this system has been the Institut Pasteur de Dakar in Senegal. The bulk of the arbovirus data in Africa has come from these laboratories and the literature represents fully as much the areas of effort as the actual distribution of the viruses. Lack of reports of a virus from a given area may indicate only that the area has not been surveyed. Data from sub-Saharan laboratories indicates that many arboviruses are widely distributed in Africa.

Tick-borne Arboviruses

The tick-borne arboviruses have been found through sub-Saharan Africa. Congo virus was shown to occur in Nigeria and Uganda soon after its original isolation in the Congo. It was also shown to cause severe disease before it was shown to be identical with Crimean hemorrhagic fever (Moore, et al, 1975).[1] Now its range extends from Pakistan to Yugoslavia as well. In Africa few serologic surveys for Congo virus have been done because the virus neither hemagglutinates nor is specifically neutralized without special extraction of antigen and sera. A serologic survey has been done in Nigeria (David-West, et al, 1974). Congo virus isolations have been made from ticks in the Central African Empire (Sureau, et al, 1976b), in Ethiopia (Wood, et al, 1978) and in Kenya (Metselaar, et al, 1974). Numerous isolation from ticks and cattle have been made in Nigeria (Williams, et al, 1972.)

[1]Bibliographic references may be found in two lists. Citations for papers emanating directly from this project are cited on pages 143-146; senior authors are Ash, Ashford, Fry, Wood. Full references for papers by other authors cited, principally in this Literature Review, pp. 6-14, and in the Methods Section, pages 17-27, are given on pages 147-150.

Another tick-borne virus, Thogoto has also been shown capable of causing severe disease (Moore, et al, 1975) but since the 2 patients from whom the virus has been isolated failed to demonstrate antibody, serologic survey data would be difficult to interpret. Thogoto virus has been isolated in Kenya the Central African Empire (Sureau, et al, 1976a), Ethiopia, (Wood, et al, 1978) and Egypt (Williams, et al, 1972).

Two tick-borne viruses Jos and Dugbe, both named for their original isolation sites in Nigeria, have not yet been shown to cause human disease. Both viruses were isolated in Ethiopia and the Central African Empire. Numerous isolations have been in Nigeria, (William, et al, 1972), Kenya (Solberg and Aldo, 1976). A serologic survey for Dugbe antibody in Nigeria seemed to indicate that antibody is rare in man and therefore the virus does not readily infect man, (Moore, et al, 1975). However, when viruses are isolated directly from ticks, Dugbe virus is by far the most frequent isolate.

Bhanja virus, although named for its original isolation site in India has a range which takes it across sub-Saharan African. It has been isolated in Nigeria, Senegal and the Central African Empire. Although the virus is known to have produced mild to moderate disease after a laboratory infection in the United States, little is known about its desease potential in Africa.

Mosquito-borne Arboviruses

Viruses carried by mosquitoes vary much more widely in their range, due in part widely differing habitat requirements of the mosquito vectors. Yellow fever virus requires for example, vectors of the genus Aedes and the most efficient vectors are in the subgroup Stegomyia. These mosquitoes breed in confined spaces, waterpots, leaf axils, treeholes and rock holes. In Africa the virus is maintained in a forest cycle involving Colobus monkeys and the tree-hole breeding mosquito Aedes africanus. Serie's work on the yellow fever outbreak in Ethiopia showed that this cycle can be entered by baboons, Papio, which then carry the virus to human habitations, and start transmission cycle with the leaf-axil-breeding mosquito, Aedes simpsoni, which then transmits the virus to man (Serie, et al, 1968).

Mosquito-borne viruses are also limited in their distribution by the distribution of reservoir hosts to maintain the virus and supply blood meals which infect mosquitoes. While some arboviruses may be transmitted transovarially in mosquitoes, to date only in the California group of viruses of North America has transovarial transmission been shown to play a major role in the transmission cycle of a virus. Two important Group B viruses, yellow fever and West Nile have been recently transmitted transovarially in the laboratory at Yale. However, field occurrence of transovarial transmission in Africa has not yet been investigated. Studies reported here, including those done by NAMRU-5, have assumed the necessity of a virus-containing blood meal to infect every generation of mosquitoes. Much field work has been done and still needs to be done to identify these reservoir hosts and link their viremias to epidemics.

Yellow fever and West Nile viruses provide an informative contrast in the way mosquito-borne viruses are limited by reservoir hosts as well as vector distribution. In most reports, yellow fever has been said to be limited to primate reserviors. Workers in the Central African Empire have shown the one species of wild rat, Steatomys could circulate enough virus to infect mosquitoes (Chippaux, et al, 1970). However, this rat is a forest dweller and this rat, alone of all the rodents tested showed viremia. Thus, the endemic area of yellow fever seems limited to forested areas where a monkey and possibly a Steatomys population can maintain the virus. By contrast, West Nile virus can produce viremias in birds, some of which migrate over great distances while they are actively viremic (Watson, et al, 1971). Laboratory evidence for the bird viremia attainable and the levels necessary to infect mosquitoes comes principally from South Africa. As little as 100 mouse LD_{50} of virus circulating in bird blood will infect 10% of the mosquitoes feeding on the birds (McIntosh, et al, 1969). Other workers have not been as successful in measuring bird viremias, however, virus has been isolated from bird tissues and blood from South Africa to Europe and into Asia Minor (Work, 1971). Widespread human disease has recently occurred in South Africa when abnormal rains increased Culex populations to high levels (McIntosh, et al, 1976).

Viruses which have African reservoir patterns somewhat similar to yellow fever are O'Nyong nyong, chikungunya, dengue. Primate reservoirs appear to be necessary. Chikungunya use the forest Aedes as vectors. O'Nyong nyong can be more widespread and occur in large outbreaks because it is carried by the much more numerous Anopheles mosquitoes. Dengue may be confined to human population; it uses peridomestic Aedes aegypti mosquitoes as does urban yellow fever. These three viruses produce clinically indistinguishable disease and in the absence of virus isolation or serology all might be reported as dengue. World War II reports of dengue in East Africa were based on clinical evidence alone. Dengue virus has been isolated in Nigeria (Carey, et al, 1971). Chikungunya and O'Nyong nyong were originally isolated in Kenya and Tanzania (McCrae, et al, 1971) but have also been found in the Central African Empire (Chippaux, et al, 1968). Chikungunya has been isolated in Nigeria (Moore, et al, 1974) and Senegal (Roche and Robin, 1967). Serologic studies indicate antibody to Chikungunya virus in Ethiopia (Rodhain, et al, 1972, Rodhain, et al, 1975), Rhodesia (Swanepoel and Crotchshak, 1974), Cameroon (Brottes, et al, 1966) and Uganda (Henderson, et al, 1972). Serologic surveys pose certain problems of interpretation with these three viruses. Dengue virus belongs to the flavivirus group and when more than one flavivirus is active in an area, one finds many multiply-reactive sera which cannot establish past infection with any particular flavivirus. Chikungunya and O'Nyong nyong virus are very closely related alphaviruses and antibody to chikungunya cross reacts with O'Nyong nyong virus. This finding has led to speculation that perhaps O'Nyong nyong virus was a one-time adaptation of Chikungunya virus to an Anopheles vector and the virus has now disappeared. No O'Nyong nyong isolations have been made in the 1970's but there is not yet sufficient evidence to justify claims of permanent demise of the virus.

Other viruses have distribution features in common with yellow fever but do not produce serious human disease. Flaviviruses in this category serve to make the results of serologic surveys difficult to interpret unless testing is done against several different flaviviruses. Zika virus distribution often parellels that of yellow fever although Zika range extends beyond African forests and into Asia. Banzi and Uganda S viruses also occur in forested areas, but are capable of spread by Culex mosquitoes which allows them to circulate in open savannah as well.

Other important mosquito-borne viruses have distribution patterns more similar to West Nile. Vectors which inhabit more open and drier areas are involved and birds and small mammals may serve as reservoir hosts. Flaviviruses in this category include Wesselsbron and Spondweni. They may produce mild febrile disease with myalgia, but no widespread epidemic disease due to either has yet been demonstrated. However, Wesselsbron can be an important veterinary pathogen in that it carries high morbidity and mortality in sheep (Munz, 1973). Wesselsbron epizootics may resemble outbreaks of Rift Valley Fever, a bunyavirus whose epidemic potential has been recently demonstrated in Egypt. Neutralizing antibody to both Wesselsbron and Spondweni has been found in South Africa, Mozambique and Angola (Kokernot, et al, 1965). Wesselsbron antibody also occurs in Nigeria (Boorman and Draper, 1968).

Alpha viruses having similar broad distribution are Sindbis and Semliki forest virus. Sindbis occurs from northern Egypt to Capetown. Originally isolated in Egypt it is still active along the Nile and while not responsible for widespread disease some CNS seems to have Sindbis as a cause (Abdel Wahab, 1970). Sindbis can produce a dengue-like disease when freshly introduced into an area. In the Orange River Valley of South Africa Sindbis circulated with West Nile in a widespread outbreak of dengue-like disease (McIntosh, et al, 1975). Sindbis can even share bird reservoir and vectors with West Nile. Semliki Forest virus has been the mainstay of viral biochemists for some years due in large part to the widely held opinion that it is a non-pathogen. Human disease has not been reported. However, a virus identical with or very similar to Semliki Forest virus has been serologically implicated in an outbreak of equine encephalitis in Senegal (Robin, et al, 1974).

The largest group of mosquito-borne arboviruses are the bunyaviruses. Several of these have been reported to produce fever with myalgia and rash -- a syndrome easily confused with dengue. Rift Valley fever (RVF), has even produced hemorrhagic disease (Van Velden, et al, 1977) in South Africa. Unpublished data from NAMRU-3 indicate RVF to be responsible for a large epidemic of dengue-like disease with occasional fatal hemorrhagic manifestations in the apex of the Delta region near Cairo. Although the vector mosquitoes reported for RVF have been predominantely *Aedes*, the very high viremias in man might permit mechanical transmission by almost of any biting arthropod. The spread of RVF north of the Sahara may have important veterinary and public health consequences. Its contagiousness poses a threat for its use in biological warfare and its natural occurrence presents a real danger of widespread human and veterinary disease. Another bunyavirus capable of causing widespread febrile illness would seem to be Tataguine virus. Tataguine uses an anopheline vector system and some of the best vectors for malaria, *A. gambiae* and *A. funestus*. Tataguine has been isolated from fevers in Nigeria (Fagbami, et al, 1972) and from the Central African Empire. It has isolated from anopheline mosquitoes in Ethiopia by Ota, et al, 1976 who found antibody to Tataguine widespread in the native population. The virus needs to be examined as a possible cause of the febrile illness often ascribed to malaria in holoendemic area.

Other mosquito-borne bunyaviruses responsible for human disease are Bwamba, Pongola, Ilesha, Bangui, and Bunyamwera. Bwamba virus has been isolated and a serologic survey conducted in Nigeria (Tomori, et al, 1974). Pongola virus is very closely related and was isolated in Ethiopia as well as in South Africa (Ota et al, 1976). Both viruses have been isolated in Kenya (Metselaar, et al, 1974). Ilesha virus has been isolated from cases of chills and fever in Nigeria (Pearson, et al, 1973) and the Central African Empire (Chippaux, et al, 1969). Serologic surveys indicate the virus is widespread in Nigeria (Fagbami and Fabiyi, 1975). It has not yet been isolated in East Africa. Bangui virus has been isolated from a febrile itlness with rash, but as yet no distriubtion information is available outside the original site, in the Central African Empire (Digoutte, et al, 1973). Bunyamwera, the type virus of the group, was originally isolated in Uganda and has a distribution covering sub-Saharan African. The virus has caused laboratory infections with encephalitis, but natural disease seems to be fever, rash and myalgia (EAVRI reports 1960-3). All of the above bunyaviruses may contribute to the fevers of unknown origin problem in Africa. Virus isolations and serologic surveys have not been as frequent or as widespread as for the alpha- and flaviviruses.

Bunyaviruses transmitted by sandflies can cause widespread febrile disease if vector populations are high enough. The phlebotomus fever viruses caused significant morbidity among troops in the Mediterranean area during World War II. These viruses were studied extensively at NAMRU-3 and there male phlebotomines were shown to be infected although not blood fed. This was the first hint of transovarial transmission in the bunyavirus (Schmidt, et al, 1971).

Several bunyaviruses are known to be transmitted by Culicoides mosquitoes. They are serologically very closely related but their significance for human disease is as yet unknown. In addition to isolation in Nigeria (Causey, et al, 1972) Simbu group viruses have been isolated in Ethiopia and Kenya. Culicoides are also major vectors for orbiviruses which are important veterinary pathogens, but in Africa no orbivirus outbreaks in man have yet occurred.

Study Areas

Five topographically and ecologically diverse areas were selected in Ethiopia, based on the results of the earlier human serological survey which showed them to have the highest arbovirus antibody rates in the country. Some of these were discrete and confined to a limited area. Others, for various reasons, involved several sites over a wider areas. The areas are briefly described below and Table 1[1] shows by month and year the number of days each site was visited during the study. One additional site was visited only once during the study.

Rift Valley, Shoa Province

a. Abiata, 07°37'N, 38°39'E, 1590 m, lies on the open, heavily grazed shores of an alkaline lake, with scattered trees, the remnants of a rich *Acacia* woodland. The area has a large resident population of Arussi Galla people.

b. Koka, 08°27'N, 39°06'E, 1700 m, is an *Acacia* and *Balanites* woodland bordering a large reservoir resulting from the damming of the Awash River, and surrounded by open farmland resulting from degraded woodland. The large resident human population is Shoa Galla people.

c. Shalla, 07°30'N, 38°30'E, 1560 m, is a deep alkaline lake, close to Abiata, only visited occasionally to sample breeding water birds on its basalt islands.

Awash Valley, Harar and Wollo Provinces.

a. Bahadu (site 1) 10°06'N, 40°36'E, 600 m, is a hot dry region of marshy grassland with riverine *Ficus* and shrubs in the open lacustrine flood-plain of the Awash River, bordered by semi-desert scrub on arid and rocky land. A large population of semi-nomadic Afar people seasonally inhabit the area together with their animals.

a' Bahadu (site 2), an area of dense *Acacia* woodland and permanent swamp about

1 All tables appear in Appendix II, pages 117-141.

10 km north of the above site, was used on a few occasions to sample woodland species.

b. Filwoha, 10°00'N, 40°32'E, an area of dense riverine Tamarix woodland, was worked on one 6-day period.

c. Aseita, 11°33!N , 41°26'E, 1260 m, is an Acacia woodland, with small areas of swamp and open grass and shrubby ground, adjoining cultivated land in a loop of the Awash River. Nearby are large areas of irregular cotton adjoining the desert. The local human population consists of semi-nomadic Afar tribesmen, and large numbers of migrant highland workers.

Gambela, Illubabor Province, 08°15'N, 34°35'E, 515 m, is a faunistically rich hot and humid area, consisting of marshy grassland with sorghum and maize plantations bordering the Baro River, and Combretum/Terminalia woodland on the surrounding higher ground. A small patch of planted riverine forest lies nearby. The local people are Anuaks with a large mixed population of other tribes.

Didessa, Wollega Province, 09°02!N, 36°09'E, 1200 m, is on the edge of the Didessa River gorge at the transition zone between three main habitat types; dense, luxuriant tropical deciduous forest, Combretum/Terminalia woodland, and savanna/farmland derived from the other two. A small local resident Shankala population is being augmented with inceasing numbers of migrant workers.

Bulcha Forest, Sidamo Province, 06°11'N, 38°10'E, 1320 m, is close to a small river flowing through extensive riverine forest into the east side of Lake Abaya, adjoining mixed Acacia/Combretum/Terminalia woodland. The forest area is subject to seasonal flooding. It is inhabited by a small local population of seasonally nomadic Gughe people.

Kelam, Gemu-Gofa Province, 04°44'N, 35°58'E, 420 m, is a mission station compound with plantings of mixed trees and agricultural crops on the bare banks of the Omo River. It was visited on only one occasion.

Methods of Field and Laboratory Operation

In all the study areas, except Gambela Dr. Ash set up a field laboratory and camp, usually for periods of 14-16 days at a time. Semi-permanent sites were used, so that the same habitat area was being sampled on each occasion. At Gambela, operations were conducted from a permanent NAMRU-5 field laboratory building with more elaborate facilities. The area round each camp was netted for birds and trapped for mammals. The numbers of each in operation at one time depended on the anticipated size of the catch, e.g. at times 3 or 4 nets caught all the birds that could be handled; at other times up to 75 nets each 12 m long, were in operation.

Animal Capture

Birds for bleeding and population monitoring were caught almost exclusively in mist mets. Successful capture of many species depended upon an intimate knowledge of their feeding and habitat preferences and their habits and ecology. Success with elusive species continued to improve with experience. Bats were all caught at night, also with mist nets, and this method proved to be much more productive than the time consuming one of searching for their diurnal quarters, although it is likely that some species were missed by this technique. Mammals were caught in baited cage traps or in some cases were shot.

A permanent field technician accompanied Dr. Ash on each field trip, and in each area groups of temporary field assistants were trained, of which varying numbers were employed on subsequent visits depending on the workload at the time. When operations continued night and day it even became necessary to develop a shift system.

Nets and traps were visited regularly and all captured animals were returned to the field laboratory in cloth holding bags. In very hot conditions netting operations sometimes had to be suspended in the middle of the days, for netting birds died very rapidly in the heat. Nets were normally maintained in use throughout the night, although it was usually necessary to raise the lower panels to permit larger nocturnally active mammals to pass under them.

Netting under these conditions in a tropical environment presented special hazards: there were many predators alert to birds entangled in nets. In this respect coucals Centropus spp. were the most troublesome but hawks, owls, ground hornbills, shrikes, jackals, mongoose species, leopards, snakes, and in water, crocodiles, presented problems at times. Occasionally the sheer numbers of "unwanted" birds present in an area, especially weavers of the genera, Quelea, Euplectes, and Ploceus necessitated furling the nets to avoid capturing them. More direct hazards to the nets themselves resulted from animals moving through them. In the case of domestic animals it was sometimes necessary to employ net guards to drive approaching animals away; wild animals such as packs of baboons running through nets, troops of monkeys feeding and defaecating overhead and fouling nets, warthogs, hippoptamuses large birds such as geese and many others, damaged nets; under some conditions huge numbers of beetles, and such other insects as locusts, dragonflies and sphingids had to be removed from nets.

Dr. Ash personally examined, identified and recorded every animal captured, and processed data from all those from which blood samples were taken. The initial objective was to obtain a sample of 50 sera from each species of wild vertebrate in each of the five areas. It soon became obvious that this target was unrealistically ambitious for the time and personnel available. It thus became necessary to modify the sampling technique, by reducing the efforts but to make sure to spread the samples taken from each species over the different months of the year, and secondly, by ceasing to collect further samples in any particular area from any species for which the first 30 samples were consistently negative (i.e. showed no serological antibody titers to group-B arboviruses).

The general policy was to undertake a broad serological survey of wild vertebrates, to indicate which species could most profitably be studied in greater detail for virus isolation attempts. Haphazard collections of tissue from such a wide range of species, as exists in the wild vertebrate fauna of Ethiopa, would have been extremely expensive in time, labor and materials, as well as resulting in the death of an unacceptably large number of animals.

All birds, except for large numbers of the more numerous local residents, were marked prior to release with individually numbered metal leg bands to obtain information on local movements, migration, population turnovers, longevity, and the results from rebleeding. Each bird was summarily examined for ticks, and most of those found were collected (Hoogstraal and Ash in prep.); an early attempt was also made to obtain blood smears from 10 individuals of each species in each area for hemoparasitological survey (Ashford, et al, 1976). Estimates of seasonal population changes were obtained from attempts to assess the numbers of each species present every day of field operations in each area, by means of trapping totals and regular observations.

Countrywide, a mapping scheme was developed to plot the distribution of all wild vertebrates on the basis of a one quarter of a degree square grid, so that the distribution of any important potential reservoir or amplifying hosts would be known. This scheme was extended to cover all important arthropod vectors (mosquitoes and ticks).

The correct identification of the vertebrates being sampled was of paramount importance. In most cases the birds were well known, and presented few problems, although for certain groups, notably the sunbirds and *Euplectes*, the characters distinguishing the various sex and age groups within and between various sepcies, were totally unknown, and it was several years before adequate identification keys were formulated. In some cases voucher specimens were retained and deposited in the British Museum before 1971 or National Museum of Natural History, Smithsonian Institution, after 1971. Small mammals, including bats, reptiles, and amphibians, presented greater problems in identification and it was necessary to collect many more for subsequent museum determination.

Collection of blood

All blood was obtained in sterile disposable plastic syringes, the choice of needle and syringe depending on the size of the animal being bled. Birds were handled and usually bled from the jugular, but in those individuals in which this vein was difficult to find - notably the dark-skinned doves- the radial vein on the underside of the wing was used, or exceptionally, cardiac puncture via the intersternal arch was resorted to. In the case of large birds such as flamingos, eagles and geese, two persons were required to hold and bleed the bird. It was usually necessary to rest small birds after bleeding to allow them to recover before release, but all birds were routinely held for a time to check that the perforated vein or heart did not rupture. A ruptured heart invariably resulted in death, but bleeding from ruptured veins could be stopped by finger pressure. From the beginning every effort was made to avoid casualties, and for this reason only small quantities of blood were removed. The method also permitted subsequent collection of additional blood samples.

Small mammals, including bats, and most reptiles and amphibia, were held in the same way as birds, but were bled by cardiac puncture, the needle being inserted directly into the heart through the sternum. Snakes and larger mammals (squirrel, mongoose) were anesthetised first. Primates were shot and bled from the heart immediately.

In practically all cases cotton swabs soaked in 70% alcohol were used to brush aside feathers or hair to ensure that the site of insertion of the needle was quite visible.

Whole blood was diluted (see below) with 10% normal saline after being transferred to a plugged sterile glass vial. It was then left standing to separate, ringed with an applicator, and spun down on a hand-centrifuge (10 mins. at ca. 4000 rpm). The sera were temporarily stored in a gas-operated refrigerator in the field and transferred to a freezer at-70°C on return to the virology laboratory at NAMRU-5.

The amount of dilution depended upon the size of the blood sample; the scale adopted in general being as follows, where the first figures show the size of the sample in ml, and the second in parentheses, the multiples of saline added: 0.20(x4), 0.25-0.30(x3), 0.35-0.75(x2), 0.8x1.0 (x1),1.0 +(nil).

Hemagglutination-Inhibition Testing (HAI)

The HAI test as developed by Clarke and Casals (1958) was performed on all sera. Acetone extraction was chosen over kaolin since kaolin varies from batch to batch. Sera were brought to a 1:10 final dilution in isotonic NaCl prior to acetone treatment, with adjustments made in the dilution procedure for specimens diluted in the field and then twelve volumes of acetone at -10°C were added to the diluted sera in an ice bath. The sera were shaken and centrifuged at 4°C for 10 minutes at 2,000 G, the acetone was decanted, and equal amounts of cold fresh acetone were added and the pellet resuspended by vigorous shaking. The sera were again centrifuged in the cold, and the acetone decanted, and then dried under vacuum. The samples of dired sera were then rehydrated to the original volume of the 1:10 dilution using pH 9 borate saline, stored overnight at 4°C to assist in rehydration, and on the following day shaken virgorously and then centrifuged for 15 minutes at 2,000 G. The supernate was removed and stored for use in the HAI test.

The test was performed by the micro method using the Linbro 96 well round bottom plates type 220-24. Virus antigens were prepared by the sucrose acetone method of Clarke and Casals (1958) and were used at dilutions containing 8 or 16 hemagglutinating units. Virus antigen titrations were done routinely in each test and antigen controls were included. Tests were repeated as indicated by the controls.

The antigens used at the outset of studies were yellow fever, West Nile, Ntaya, Zika, Semliki Forest, Chikungunya and dengue type 1, but such a large number of tests used most of the serum sample. In order to save enough serum to confirm HAI results by neutralization the antigens were reduced to West Nile, Nyaya, and Zika. When Dr. Wood assumed direction of the testing in 1974, over

10,000 sera had been tested against the 3 antigens, and it was decided to continue testing against these antigens followed by neutralization testing in mice and in tissue culture when available.

The HAI tests were performed in the following manner. From the 1:10 dilution of sera obtained in acetone treatment, three serial two-fold dilutions were made in pH 9 borate saline, and for each serum, 4 dilutions were made in test tubes 1:10, 1:20, 1:40 and 1:80. One 0.025 ml drop of each dilution was added to each well in the micro-plate, so that each plate held 24 sera and a separate plate was used for each antigen. The antigen added to all wells on a plate contained 4-8 hemagglutinating units. The plates were incubated overnight at 4°C, and on the following day they were warmed and two drops of male goose cells were added to each well. The goose cells were suspended in a phosphate buffer of a composition such that when mixed in equal parts with pH 9 borate saline the optimal hemagglutinating pH was reached for a particular antigen. The buffers for goose cells were prepared according to the method described by Hammon and Sather (1972). The plates were incubated for 1 hour at 37°C and then read.

Complement-Fixation Testing (CF)

The CF technique has not been applied successfully to avian sera by most workers. Therefore, only human and other mammalian sera were tested by CF in the present study. The test was performed as modified by Casals (1967) with the following exceptions. Sheep cells were obtained from local fat-tailed sheep. The cells were drawn into Alsevers solution, defibrinated by shaking with glass beads, and allowed to equilibrate for 24 hours before use. The micro plates used were Linbro V-bottoms type 220-25, and all antigen and serum dilutions were made in test tubes rather than with diluting loops.

Sera were initially diluted 1:4, inactivated for 20 minutes at 60°C, and then added to plates as 0.025 ml drops followed by the same amount of diluted complement and antigen. Plates were held at 4°C overnight, and on the following day they were brought to room temperature (22°C) and sensitized sheep cells were added at the rate of one 0.025 ml drop to each well. The plates were incubated at 37°C for 30 minutes, placed at 4°C for 3 hours, and then read. Complement controls included the standard complement titration incubated with the test together with 3 two-fold dilutions of the dilution of complement used in the test.

Neutralization Testing

Neutralization testing of bird sera was undertaken as a mouse protection test because of the limited quantity of serum and the numbers of viruses surveyed. Sera were diluted 1:4 in PBS and inactivated at 56°C for 30 minutes. Viruses were titrated in 1-day-old mice and LD_{50}'s calculated for each virus stock by the method of Reed and Muench (1938). The virus stocks were diluted in pH 9 borate saline with 0.75% bovine serum albumin (BABS) to contain 50 mouse LD_{50}'s and mixed in equal parts with the diluted sera to give 25 LD_{50} final concentration. In this way it was possible to approximate the more widely used method reacting 100 LD_{50}'s of virus with undiluted sera: the earlier work of Reeves and Hammon (1962) had shown the neutralization antibody of avian sera was detectable only with low virus dosage. After 1-hour incubation at 22°C the virus serum mixture was inoculated intracerebrally into a litter of 1-day old mice, and the mice were held for 21 days to determine protection rates. The Group B viruses tested were: West Nile, Zika, Ntaya, Wesselsbron, Spondweni, and Banzi.

Human and other mammalian sera were collected in greater volumes and were therefore amenable to conventional neutralization testing, which was carried out in mice using a constant serum-virus dilution method. Sera were diluted

1:10 and mixed in equal volumes with serial 10-fold dilutions of virus and incubated for 1 hour at 22°C; the dilutions were then transferred to an ice bath and injected into 1-day old mice at two litters per dilution. Litter size was standarized at eight infant mice, and in each test a control titration of the virus in normal mouse serum was included. LD_{50}'s for each sera were calculated at 21 days by the method of Reed and Muench (loc. cit.) and compared with the virus titration. A 100-fold reduction in the virus titer was considered specific neutralization.

Virus Isolation Studies

The HAI results were used as a basis for determining which wild vertebrates had high percentages of antibody positive individuals, and these species were selected for sampling for virus isolation attempts. In the absence of such clues it would only have been possible to sample at random for virus isolation the large number of birds and mammals being captured. The production of mouse litters in Ethiopia peaked at 300 litters/week, from which there were also other demands, and was only sustained at this level for the last two years. Beginning in 1975, samples of brain, kidney, liver and spleen tissues and blood were collected from examples of the selected species. The tissues were frozen in liquid nitrogen in the field and transported to the NAMRU-5 laboratory for testing. Here they were ground by mortar and pestle and made into approximately a 10% suspension in BABS containing 500 units of penicillin and 500 mu of streptomycin per ml. Specimens were centrifuged for 30 minutes at 1000G and the supernates were injected intracranially into 1-day-old mice, one litter per specimen and 0.02 ml per mouse. The remainder of the supernate was stored at -70°C until all the injected mice survived for 21 days or until material was needed for reinjection.

Dead or sick mice were collected and stored frozen at -70°C. Later, they were thawed and the brains aseptically removed and ground by mortar and pestle into an approximate 10% suspension in BABS. Suspensions were then centrifuged for 30 minutes at 1000G and injected intracranially into 1-day-old mice. The mice receiving mouse brain injection were observed for signs of CNS disease on death, and those affected were frozen and considered to represent passage one (PI) of the virus. Viral isolates were taken through 3 passages routinely. P3 material usually consisted of 5 litters of mice, and those were passed through a 0.4 mu millipore filter and cultured to make sure bacteria were not responsible for mouse deaths. Bacteriologically sterile P3 material in BABS with 500 units of penicillin and 500 mu of streptomycin per ml was injected into 20 litters of day old mice to prepare immunizing antigen for weanling mice. The brains were harvested when 10-20% of the mice had died, and were weighed and ground as a 10% suspension in 0.85% saline in a Vurtis homogenizer. The brain suspension was then centrifuged for one hour at 8500G, to provide a clear flesh colored solution. This solution was aliquoted into 5 parts, of which two parts were set aside for inactivation when patterns of mouse deaths suggested a Group B virus might be present. Viruses were inactivated by adding one part of a 1% v/v aqueous solution of Betapropiolactone (BPL) to nine parts of clarified mouse brain solution and holding overnight at 4°C.

Weanling mice at 4-6 weeks old were injected once a week with 0.5 ml of antigen intraperitoneally (IP). For virus suspected to be Group B, the mice received their first two injections as BPL inactivated antigen. This was necessary since the most commonly reported Group B virus in African birds, West Nile, would often kill all adult mice. After 5 IP injections mice were held for a week and then exsanguinated by cardiac puncture. From 100 mice, 40 ml of serum was obtained, and this was then tested by CF against the original antigen used to immunize the mice. If a reaction was obtained, 15 ml of the serum was aliquoted as 1.0 ml amounts, lyophilized and sent to YARU along with a similar quantity of antigen.

Once an antigen antibody CF system had been established for an unknown and presumed viral isolate, preliminary identification attempts were made in Ethiopia, using antisera made to multiple arboviruses obtained from the reagents branch of the National Institutes of Health (NIH). Twenty-one sera were used which permitted screening for over 150 different arboviruses. All unknown antigens reacting in a homologous CF test were tested against these 21 pools of antisera each containing antibodies to six or more viruses. Reactions were recorded and forwarded to YARU to aid in making a final identification.

The antisera used were Group A , Group B, Polyvalent Bunyamwera, Polyvalent California, Polyvalent Kemorovo, Phlebotomus Fever Group, Quaranfil Group, Simbu Group, VSV Group, Polyvalent Anopheles A, Polyvalent Bwamba, Polyvalent Congo, Polyvalent Palyam, Polyvalent Rabies, Polyvalent Sera numbers: 1, 4, 7, 8, 10, and 12. When tick agents were tested, Jos antiserum was also included. For Congo polyvalent antisera the components were available in Ethiopia, but as a rule specific identification had to be carried out with monospecific antisera at YARU.

Serological Results from Wild Vertebrates

A total of 16163 sera were collected from vertebrates animals and tested serologically in Ethiopia, but the results from 920 sera were lost during the evacuation. Of the 15243 serum test results available, 13115 were from birds 926 bats, 796 mammals other than bats, 259 reptiles and 147 amphibians (Appendix I). The serological results of Hemagglutination Inhibition Testing are summarized by animal family in Table 2. An additional 651 sera were processed from humans.

Amphibians and Reptiles

No amphibians showed a high percentage of antibody reaction. Among the reptiles only results from 200 individuals of two *Agama* lizard species were significant. Of 164 *A. agama* tested, 32 or 19.5%, were positive; of 36 *A. doriae*, 6 or 16.7% were positive; 34% of the positive ones were monospecific to Ntaya.

Birds

There are 827 species of birds from 81 families that occur in Ethiopia, but only about half of these occur in the study areas. Sera were obtained from 391 (47.3%) of the species found in the country, and from 62 (76.5%) of the families.

When those species and families of birds are considered for which there are samples of 10 or more individuals and where 10% or more of them have positive antibody titers, it is found that there is wide representation. Altogether 45 species in 22 families are in this category, representing 11.5% of the families examined. The species and families of greatest significance in arbovirus cycles are listed in Table 3. A curious fact which emerges from these data, by comparing Table 3 with Appendix I, is that in some families, a single species stands out as being important, e.g. Nectarinia senegalensis in the Nectariniidae, whereas other species within the same family are of apparently little importance; in other families, e.g. the Columbidae, a large proportion of the species possess antibody titers. This phenomenon emphasizes the need for broad surveys in attempts to locate the key vertebrate species in natural cycles of transmission.

Various attempts have been made to categorize the affected species ecologically in terms of habitat preference, feeding and roosting habits, and vulnerability to ticks and mosquitoes, without any common factor emerging. With more knowledge about the identity of the infecting agents and the arthropod vectors involved it may be possible to obtain clues which would enable some attempt at ecological segregation to be made.

An attempt to compare the infection rates between areas are thwarted by the unevenness of the sample sizes and the variation in vertebrate species distribution. In an effort to overcome the difficulties, those species with samples of 10 or more individuals and with "infection rates" of 10% or more are listed in Table 4. The totals for each locality suggests that Gambela was highest with 30.6%, followed by Awash Valley (19.8%), Bulcha (19.4%), Didessa (15.8%) and Rift Valley (=Koka) with 7.1%. However, caution is needed in the interpretation of these data; if for example, the totals for only the two species Turtur afer and Camaroptera brevicaudata which occur in all areas are considered, the order changed, with Awash Valley (17.6%), Gambela (8.7%), Bulcha (6.9%), and Koka with 1.4%.

The remarkable degree of variation within the same species from one area to another is also demonstrated in Table 4. Some, such as Milvus migrans, have a consistently high percentage of positives in the areas in which they were sampled, whilst others, such as Turtur afer, have a very wide range. It is difficult to account for these differences, unless they are connected with the relative abundance or differences in geographic distribution of arthropod transmitters.

Mammals

There are 73 species of bats from 9 families known in Ethiopia, but only about 70% of these are recorded from the study areas. Sera were obtained from 44 of the species (60.3%) and 8 of the families (88.9%).

When the data for bats in Table 2 are examined and compared with Table 5 which shows the families and species with significant antibody titers, a striking point emerges. In the fruit bats, family Pteropodidae, 613 individuals were examined, of which 16.5% were positive; whereas in the insectivorous bats, all other bat families, 313 individuals were examined, of which 5.1% were positive. Clearly all seven species of fruit bats are of potential importance, but of the insectivorous bats only one species (2.7%) among the 37 species was positive at the 10 percent level (Table 5). The infection rates in fruit bats also vary within species in much the same way as they do for birds (Table 6).

Among the other mammals (Tables 2 and 7) only four species in three families show significant antibody titers. The two Cercopithecidae monkeys, Papio anubis and Ceropithecus aethiops, are of particular interest. Forty percent of the feral domestic cats examined at Gambela were positive, suggesting that this is an animal which would repay further attention. The situation in the rodent family, Muridae, is remarkable, for only one species, Arvicanthis nilotica, of the ten species checked in this family, showed significant antibody titer.

Retested Birds

A number of birds after being captured and bled for serological testing were recaptured and rebled on subsequent occasions in their original locality. A total of 24 individuals of 7 species were involved, and their repeat serologies (Table 8) show several patterns of test results as follows:

a.) Serology negative at both initial and subsequent testings. Six Streptopelia decipiens in this category were rebled with negative results after 10 days (1 bird), after 4 months (4 birds) and 12 months (1 bird); an adult Ceryle maxima was still negative 11 months later, a Pogoniulus pusillus after 5 months, and 4 Turdus pelios, all first bled as adults, were still negative after 13, 24, 41, and 54 months respectively.

b.) Serology negative at first bleeding but positive at subsequent bleeding: One Burhinus senegalensis of uncertain age, but older than a juvenile, was positive 17 months later; a Streptopelia decipiens of similar age was positive 20 months later; 5 Turdus pelios, all first bled as adults, were positive at 10, 14, 17, 38, and 43 months later. These results conclusively that adult birds can be infected.

c.) Serology positive at first bleeding but negative or with lower antibody titers at a later date: One Melierax metabates with a result of WN3-N2-Z2 read WN3-NO-Z2 5 months later, indicating a reduction in antibody to Nyaya; a Dryoscopus gambensis decreased from 3-0-1 to 2-2-0 after 5 months (the increase in Ntaya suggests a reinfection); 5 Turdus pelios, of which 4 were first bled as adults, showed antibody decreases as follows: 4-2-4 to 2-0-2 after 6 months; 2-3-0 to 0-0-0 after 8 months; 2-2-3 to 0-0-0 after 8 months; 1-1-0 to 0-0-0 after 11 months; 0-1-2 to 0-0-0 after 35 months. These figures suggest that a decline in antibody titers in the order of 2 points per 6 months may be expected assuming that there has been no intervening reinfection.

d.) Serology positive at first bleeding but showing antibody increase at subsequent bleeding: Two *Dryoscopus gambensis*, of which one was included in c above, showed antibody increase from 3-0-1 to 2-2-0 in 5 months and 2-1-1 to 4-2-4 in 48 months; 4 adult *Turdus pelios* changed from 4-0-0 to 3-0-1 in 14 months, 4-2-2 to 1-4-3 in 15 months, 3-0-1 to 3-1-2 in 16 months and 2-2-2 to 2-3-0 in 20 months. These results further support the finding that adult birds can be infected, and also indicate that it is not unusual for birds to be repeatedly infected in their lifetimes.

e.) Serology remaining unchanged at subsequent bleeding: One adult *Turdus pelios* at 2-0-2 had the same titers 5 months later.

f.) Fluctuating antibody titers: Four *Turdus pelios* were bled on 3, 3, 4, and 5 occasions respectively. One post-juvenile decreased from 0-1-2 to 0-0-0 after 35 months, then increased to 4-2-4 14 months later, decreased to 2-0-2 six months later and was at this same level a further five months later; an adult decreased from 1-1-0 to 0-0-0 after 11 months, and had increased to 2-1-1 after another 38 months; an adult at 2-2-2 changed to 2-3-0 after 20 months, decreased to 0-0-0 8 months later, and then increased to 4-3-3 ten months later; the final bird increased from 0-0-0 to 4-0-0 after 43 months and decreased to 3-0-1 14 months later. Two of these thrushes are of particular interest in that each must have been infected on at least two occasions. Multiple infections are not surprising in the first three *Turdus pelios* which were from Bulcha, where 51% of all the birds examined of this species were positive.

Seasonal Variation in Antibody Titers

Owing to the variation in sample size on a monthly and regional basis it is difficult to examine the possibility of seasonal variations in antibody titers. The figures for Turdus pelios are presented in Table 9, where the total overall figures might suggest that the proportion of birds with antibodies was low at the height of the dry season, and increase noticeably with the onset of rains, but this is not borne out by an examination of the individual figures from each of the areas. At Didessa the percentage of positive birds is highest in the first quarter of the year, at Bulcha they are highest in the third quarter, at Gambela in the second and third quarters, and in the Rift Valley in the last.

Neutralization Testing of Avian Sera

It was recognized early in the study that many sera had HAI antibody which reacted to more than one Group B virus, so that virus neutralization testing was necessary to confirm which one was responsible. In most viral infections, neutralizing antibody is accepted as proof of exposure to specific viruses. However, workers at YARU cautioned informally against regarding even neutralizing antibody as complete proof, in the case of Group B viruses, and recommended a program of virus isolation as necessary additional information for certain identification.

In addition because the original study program involved live release of all birds and animals surveyed, individual serum sample volumes were often small. Micro-neutralization testing in cell culture was prepared for, but not put into operation because of the need to concentrate on isolation procedures. Neutralization testing was therefore only carried out on larger rerun samples.

HAI positive sera having at least an 0.5 ml volume were selected for testing in mice. Prior to 1974, 33 sera were tested in adult mice using 50 to 100 adult mouse LD_{50}'s of virus (Table 10). But because virus LD_{50} titers differ between adult and infant mice, and because work by Reeves and Hammon (1962) has indicated that avian sera neutralization activity is weak, it was decided a more sensitive test would result from using suckling mice and 25 suckling mouse LD_{50} of virus. The results of the suckling mouse system testing 276 sera in suckling mice are presented in Tables 11 and 12. The sera had monospecific and crossreacting anitbody at titers from 1/10 to 1/80. In as much as sera tested in adult mice prior to 1974 were chosen for high titer as well as high volume, the results in Table 10 cannot be compared directly with those in Tables 11 and 12.

The predominant neutralizing antibody in avian sera was antibody to West Nile virus and this virus seems to have avian cycles in all the study sites. Ntaya virus antibodies are found less frequently and yet are almost three-times more frequent than any of the other group B virus antibodies. Since Ntaya was originally chosen because it had been isolated in Ethiopia (Serie, 1968) and because it had one of the widest cross reactions among the Group B viruses, it cannot be concluded that all the Ntaya neutralizing antibody was specific. However, a total of 11 sera, representing all the study areas, showed antibody to Ntaya and might indicate its presence in Ethiopa. The results also suggest Banzi, or its close relative Uganda S, may circulate at Bulcha, Gambela, Aseita, and Bahadu. The relatively small samples of sera tests from Didessa, Koka and Abiata may account for the apparent absences of Banzi from these localities. Zika neutralization antibody was found in birds only in Gambela, yet Zika HAI antibody was found in the same material in other study areas, and human sera neutralized Zika virus at Didessa. The two avian sera that neutralized Zika also neutralized West Nile and Ntaya viruses to a lesser degree, and therefore the tests are of less value in establishing the presence of Zika virus in Gambela than they would have been if they had been monospecific. Likewise, the sera that neutralized Spondweni virus from Aseita also neutralized Banzi and Ntaya viruses and thus offers little proof of the presence of Spondweni at that site.

The serum from Gambela which neutralized Wesselsbron also neutralized Ntaya virus to a very limited extent, protecting only 1 of 8 mice. This result is worth noting because Wesselsbron virus causes veterinary disease much like that seen with Rift Valley Fever virus. The virus has not been shown to cause severe human disease, but like Rift Valley it cannot be generally studied outside Africa. Information on Wesselsbron coming out of South Africa is worth following up to assess its disease potential.

The results of neutralization testing in adult mice show a somewhat similar picture (Table 10). The combined Banzi and Uganda S antibody is more frequent than when Banzi alone was tested for in suckling mice. Uganda S antibody is found in two Koka sera, West Nile antibody was found in all the study areas being worked prior to 1974. Aseita area came into use later. Negative sera in HAI tests were tested in adult and suckling mice and did not neutralized virus.

Serological Results from Human Samples

Great difficulties attended the collection of blood samples from most of the peoples of Ethiopia. However, after long acquaintance with the local people in the study areas Dr. Ash was able to obtain samples for serological testing. Additional samples for virus isolation were collected from febrile patients.

Hemagglutination-Inhibition (HAI)

The results from human sera from Didessa, Koka, Bulcha and Bahadu used in HAI testing are listed in Table 13. They suggest that additional testing would have been desirable, but further testing is no longer possible as the sera collections were abandoned in Ethiopia.

Because the Didessa and Bulcha sites were involved in the 1962-1964 yellow fever outbreak, data from individuals 12 years old or less are segregated. Gambela was surveyed independently during a study of a fever of unknown origin, so that additional samples were not taken for this study.

At the Didessa site there may have been further yellow fever infection since the 1962-64 epidemic. One of the HAI positive sera from an 8 year old girl also neutralized $10^{2.1}$ mouse LD_{50} 's of yellow fever antigen. Although the titers are low, the fact that all three tests were monospecifically positive seems to indicate experience with yellow fever virus. However, unlikely though it may be for a resident Shankala girl, infections may have been acquired in travel elsewhere, and the possibility of fever vaccination in the area near a missionary clinic cannot be entirely eliminated.

A second HAI positive serum is not CF or neutralization positive and may represent a very early infection, or more likely, an antibody to a Group B virus other than those in the test. Large numbers of HAI positive adults bear out the supposition that it was an epidemic area of yellow fever. Zika virus often travels with yellow fever and it, too, is found in Didessa. West Nile has also been present as shown neutralizing antibodies in adults. West Nile antibody titers are low at Didessa; all 27 sera reacted to only 1/10. Three adult sera specifically neutralized West Nile virus but no neutralizing antibody was found in the children's sera. Likewise only three adults' sera showed CF antibody. Possibly these results indicate a West Nile transmission cycle; either long past or in an early stage, but more likely many of the low titers represent antibody to a Group B virus other than those tested and may be really a cross reaction.

Dengue antibody titers are also low. The sera from Didessa were not tested by neutralization. However, other sera from Koka showing HAI antibody to dengue did not show neutralizing activity. If engue were being transmitted in these areas higher HAI titers and the presence of neutralizing antibody would exist.

It would seem that there has been transmission of Zika virus in Didessa because of the presence of sera with HAI titers of greater than 1/10 and neutralizing antibody. Similarly chikungunya virus seems to have been present there also since the majority of the HAI positive sera were 1:80. Chikungunya neutralizations were not done.

The presence of the three viruses in Didessa are sufficient to account for the large number of multiple reactive sera, and there is the possibility that another Group B virus may also be present.

Koka is not known to have been affected by the yellow fever outbreak of 1962-64, and at present there are no ecologic features in the area that would favor yellow fever transmission, nor has there been a local vaccination campaign. Nonetheless, the adult antibody titers are real because the HAI monospecific positives and some of the multiply reactive sera neutralized yellow fever virus.

In sera from both adults and children there is low-titered HAI antibody to West Nile virus. In the sera from both age groups the HAI multiple reactors neutralized West Nile virus, whereas the three monospecific HAI positive sera did not. All the sera were tested in neutralization against West Nile, Yellow fever, and dengue I, and the presence of neutralizing antibody to West Nile indicates that man is infected by this virus. Several isolations from resident birds confirm a natural cycle of West Nile virus in this area.

Zika virus HAI antibody in Koka poses the same problem as yellow fever antibody since the two viruses share vectors. One of the sera reacted at 1/40 in HAI but the others were 1/10. Dengue antibody titers were low also and were not confirmed by neutralization. Chikungunya antibody was almost absent being represented by only one adult serum reacting at 1/10.

Yellow fever is supposed to have occurred in the forested Bulcha area. The serum collection was taken from the Guji people who live in the forest. While many of the sera were multiple reactors in the HAI test, only three neutralized yellow fever and no neutralization occurred for West Nile and Zika. There were high HAI titers for West Nile monospecific and the virus has been isolated from birds taken in the area. Neutralizing antibody should have been detectable even in small samples of sera. No neutralizing antibody was present for either Zika or Dengue but the large number of cross-reacting HAI sera suggest the presence of a Group B virus other than those tested.

A bird serum from Bulcha neutralized Banzi, so that virus, or its very close relative Uganda S, might have been active in the area, but human sera were not checked against these viruses.

The HAI test on the 51 sera collected from Afar people in Bahadu showed only that multiple Group B infections occur at a very early age. Two children's sera from Aseita had high monospecific HAI titers to West Nile. Six adult sera neutralized West Nile virus. Certainly one of the Group B viruses active in the region is West Nile.

In addition because of the presence of <u>Culex thalassius</u> mosquitoes and the known presence of migrant birds from Asia in Ethiopia, the possibility of the occurrence of Japanese encephalitis (JBE) was considered. In a check for neutralizing antibody three adults and one child had monospecific JBE neutralizing antibody. However because JBE and West Nile are very close antigenically much work would be needed to substantiate this finding. Three sera also neutralized Ntaya virus and Banzi neutralization antibodies were found in birds so that candidate Group B agents are available to account for Group B multiple reactive sera, but definite results do not seem possible without the sera which were abandoned in Ethiopia.

<u>Compliment-Fixation (CF) Testing</u>

Sera positive in the HAI test were tested against West Nile, Zika, yellow fever and chikungunya antigens by CF. The rational was the reported decline in yellow fever CF antibody following injection (Strode, 1951). A positive CF was evidence of a recent infection. While antibody decline has not yet been disproved for yellow fever, CF antibody to dengue virus has been demonstrated 20 years after infection and antibody to St. Louis encephalitis five years after infection (Evan, et al, 1974). There appears to be no information for West Nile, Zika and chikungunya viruses. However, one should probably not use CF as evidence of recent infection in any area where several Group B viruses circulate or until studies are undertaken with more Group B viruses to show antibody duration.

The CF results are presented in Table 14. Since the CF is less specific than HAI test, the West Nile HAI monospecific positive sera in Bahadu would reinforce West Nile HAI results obtained there. West Nile is one of the infecting viruses that causes the universal Group B cross-reacting antibody. At Bahadu two sera reacted with yellow fever and two with West Nile, but most sera were either multiple reactive or anticomplimentary. The Bulcha sera were from the forest-dwelling Guji people so that much of the anticomplimentary activity may have been due to malaria. There was much less anticomplimentary and less multiple reactive sera at Koka, ie. only 10 multiple reactive as compared with 35 by HAI. Also there appeared to be no CF antibody in children to yellow fever and Zika, but there was to West Nile proving additional evidence that West Nile virus has circulated in the Koka area. In Koka adult sera, the CF pattern for yellow fever and West Nile parallelled the HAI pattern, but less CF antibody than HAI antibody was found to Zika virus. At Didessa there was moderate CF antibody to yellow fever. About half of the adults with yellow fever neutralizing antibody also had CF antibody. Restimulation by yellow fever exposure or exposure to another Group B virus is possible, and yellow fever CF antibody seems to have persisted for several years. There was surprisingly little CF antibody to West Nile if the 1/10 HAI West Nile positive sera really resulted from West Nile infection.

In all areas the numbers of sera reacting with chikungunya virus was high and the vast majority were reactions at only 1/8. However, in the absence of neutralization data these results should be interpreted with caution.

Neutralization Testing

Virus neutralization tests on human sera also showed that West Nile virus infected man at Didessa, Koka, and Bahadu (Table 15, compare Table 13). However, in the absence of clinical findings and paired sera, neutralization data do not indicate clinical disease, but only that infections have occurred. There was surprisingly little neutralizing antibody in the sera collected at the Bulcha site yet there were a large number of cross reacting HAI sera. The most likely explanation would seem to be that the viruses used in the test were not the viruses responsible for the HAI antibody and that there may have been an outbreak of a still unknown Group B virus different from yellow fever, West Nile, Zika and dengue. However, neutralizing antibody to dengue does not appear in any study site, and dengue antibody were only found in an occasional 1/10 HAI titer as monospecific antibody in the sera collected as part of the Ethiopia Government Yellow Fever Vaccination Program in Sidamo Province.

Some Japanese B encephalitis (JBE) antibody testing was undertaken on avian and human sera at Bahadu. The human antibody appeared monospecific in the traditional method of neutralization testing and three sera currently at YARU will be tested in a kinetic neutralization test to ascertain that it is not West Nile. Until this test is positive, no assertions should be made about the presence of JBE in Africa.

A child's serum from Didessa provides additional evidence that yellow fever was still being transmitted in the old epidemic area, and emphasizes the fact that yellow fever must still be considered when evaluating any reports of hemorrhagic disease in Ethiopia populations. While the circulation of the three viruses used in the test, yellow fever, West Nile, and Zika are enough to explain the multiple reactive neutralization antibody sera, the possibility of the circulation of one or more other Group B viruses is not excluded and demonstrates the need for virus isolation as well as serology.

Virus Isolation

After the initial serological survey, it was feasible to begin isolation of virus from some of the animal hosts that showed a higer rate of previous infection through serology. Isolations were run on wild vertebrates, sentinel mice, mosquitoes and ticks. Termination of the field work curtailed this portion of the study but continued laboratory work on isolations is in progress under Dr. Owen Wood at Yale where some of the material salvaged from Ethiopia has been sent.

Wild Vertebrates

West Nile, isolated from seven species of birds on ten occasions from Koka material and twice from Bulcha, was the only Group B virus found so far in birds (Table 16). A large amount of unprocessed material collected from these and others regular sites was abandoned in Ethiopia when the laboratory personnel were evacuated, but some samples at first and second passage level in suckling mice were later recovered and are now at the Yale Arbovirus Research Unit (YARU) awaiting further processing. Six additional isolates need data matching (Table 16).

One other virus, Dugbe, recognized previously as widespread in Africian ticks, was isolated from seven species of birds on 13 occasions and one mouse in Ethiopia. Ten of the isolations from birds were from Koka, two from Bulcha and one from Aseita; the mouse was from Gambela.

There were two Arumowot isolates from rodents at Aseita, an Abu Mina isolate from a bird at Dubte, near Aseita, and a Bunya virus from a bird at Bulcha. Three isolates are still under study for identification, and three were abandoned in Ethiopia before they could be identified (Table 16).

Sentinel Mice

In attempts to obtain virus isolates resulting from direct infections of uninfected material, litters of new-born mice were exposed to mosquitoes. Two procedures were adopted using new-born litters of pregnant white laboratory mice taken into the field:

a.) Litters were exposed night and day as bait for continual feeding by mosquitoes;

b.) litters were exposed only at night in small wire cages, open at the top, bottom and sides, under different conditions of habitat and height.

From the mouse litters exposed to mosquitoes at Bulcha, where in November 1976 both the infant mice and mothers died in the field, one isolate has been obtained. This isolate, Ethan 4872, appears by compliment fixation to be Germiston virus, a human pathenogen in South Africa. Antigen prepared from five other viral isolations from exposed mice reacted in compliment fixation with Ethan 4872 and also appear to be Germiston.

On return from the field, all litters were maintained in the laboratory, and all ailing and dead mice were processed for virus isolation. It is not known at present how much of this material has been salvaged from the NAMRU-5 laboratory in Ethiopia.

Mosquitoes

As mosquitoes were almost certainly the most important anthropod vectors in arbovirus transmission in Ethiopia, large numbers were captured for virus isolation attempts. Dr. Vernon Lee routinely examined large pools of mosquitoes from the study areas at different times of the year. His results are being prepared for publication. Dr. Ash augmented these catches by the use of mosquito traps baited with birds and mammals. In order to capture a broadly representative sample, trapping was spaced throughout the year, in various habitat types, and at a variety of heights from ground level in open areas to the tree-tops in forests. All mosquitoes were identified by Dr. Lee, and all larger catches were preserved for virus isolation. This important part of the project cannot be completed until it is known how much of the arthropod material has been salvaged from Ethiopia, and until Dr. Lee, who is at present engaged in a new project in Indonesia, has time to devote to it.

Ticks

As part of the NAMRU-5 program for study of Crimean-Congo hemorrhagic fever (CCHF) and other tick-borne viruses in Ethiopia, ticks were collected from vertebrates for isolation, especially in the southern and western parts of the country. A total of 6,777 ticks were collected from domestic animals and vegetation and grouped into 410 pools. The ticks were processed for testing in 4-day old mice. Isolates were screened by CF (Casals 1967) and identifications confirmed at Yale University. Twenty-five virus strains were found including Congo Virus (1), Thogoto Virus (1) dugbe virus (7) and Jos virus (8) from Amblyomma, Hyalomma, and Rhipicephalus ticks, a mouse and a warbler. Ten additional strains await identification. The details were reported recently by Wood et. al. (1978).

Related Biological Studies

While the field collections of blood samples and laboratory testing for serology and virus isolation were under way, a number of related field and laboratory studies on the vertebrate hosts were also in progress. These studies have resulted in a number of publications and have considerably expanded our knowledge and understanding of the distribution and ecology of vertebrates in Ethiopia. This knowledge has been and will continue to be of great value in interpreting the virological results of the study.

Bird Blood Parasites

There is evidence from earlier work that in some species of birds, weakened or ailing ones are more liable to heavy infestations of endo- and ectoparasites (Ash, 1960). If a correlation could be demonstrated between parasitemias and arboviral infections, then a rapid method of survey for possible reservoir or amplifying vertebrate hosts would be available. With this objective, over 8000 smears were collected from mammals, birds, reptiles and amphibia in the study areas. The results of examination of the first 5000 of these have been published, and compared with the serological results from the same species, and in most cases the same individuals (Ashford, et al, 1976). Detailed analysis failed to indicate any correlations (the relevant data are deposited at the Smithsonian Institution).

Zoogeography: Faunal Mapping

In the intensive surveys in the special study areas the serological results soon indicated that certain families and species of birds and mammals were of potential significance in arbovirus cycles. The status of the many species yet to be examined was not known. It was therefore important to plot the distribution of all wild vertebrates and arthropod vectors throughout the country in order to delineate areas where arboviral infections may be circulating.

At this stage "Distribution Map Scheme for Ethiopia" was initiated. The ultimate objective being to produce a series of overlay maps for the countryside distribution of vertebrate vectors and arboviruses. The source material for the maps was to be new observations by Dr. Ash, observations supplied by voluntary contributors abstracted data from published and unpublished literature, and distributional data from collections in museums.

As the mapping scheme was of peripheral interest to the main objectives of the arbovirus project and because mapping all fauna was obviously too large a task for one person, various sections were apportioned amongst other people who had interests in particular groups. Dr. Ash was responsible for birds and ticks from wild vertebrates, of which the 840 bird maps have been completed for eventual publication, and a paper on the tick distribution and host-parasite relations is currently in preparation in collaboraboration with Dr. Harry Hoogstraal of NAMRU-3. All the other wild vertebrate data to which the arbovirus project contributed much information, became the responsibility of Dr. M. J. Largen of Addis Ababa University, Dr. D. Koch of the Senckenberg Institute Frankfurt am Main, West Germany, and Dr. D. W. Yalden of the University of Manchester, U. K.; these are being published in a series of papers, of which the first dealing with the bats has been published, the second on rodents is in press, and the others are in preparation. Mr. P. Neri, an entomologist with NAMRU-5, collated all the mosquito data and has completed the maps ready for publication. The scheme maps were adopted widely for use in Ethiopia, by the Wildlife Conservation Department for plotting the distribution of game animals, by the United Nations Food and Agriculture Organization for plotting pests of agricultural crops, the Ethiopia Institute for Agricultural Research for plotting rodent pests and agricultural fungal diseases, by botanists, entomologists and others.

The mapping grid used was based on a one degree square, and each square or part of one throughout the country was allotted a number; each square was then divided into four of which each quarter was lettered A, B, C, D. The squares were thus lettered 1A, 1B, 1C, 1D, 2A ... and so on through 132B. Being a quarter of a degree square each small square was thus about 1173 square miles or 3140 km^2. This was deemed to be smallest practical unit that could be used in a country the size of Ethiopia, and with such limited manpower.

Samples maps are shown for two species which are apparently of importance in arbovirus transmission cycles. The Black Kite, Milvus migrans, is a common and widespread breeding resident in Ethiopia, whose numbers are augmented by large numbers of Paleartic migrants in September-April (Fig. 1).[1] The African Thrush Turdus pelios, is a breeding resident, mostly below 1500 m, which is subject to local migratory movements (or, more probably, post-nuptial dispersal) (Fig. 2).

Some information is available from 400 of the 486 squares covering the country, but the quantity of data from each varies greatly. Dr. Ash personally visited 249 of the squares. Those covered by the project study areas are very well known; others have only been visited on one accasion. The obstacles to complete coverage are mainly the distances involved, the difficulty in travelling to and within some regions, and the fact that throughout the duration of the

[1]All figures appear on pages 151-153.

project there was always warfare in one or other part of the country.

Collections

Certain groups of mammals and birds were poorly known in Ethiopia and indeed, in Africa as a whole. It was therefore necessary to collect voucher specimens for some species. The opportunity was also taken to collect series of some difficult groups in order to establish characters to identify them. Specimens of little known species were also collected, and wherever possible any casualties resulting from netting or bleeding were preserved.

The total of 4946 vertebrates collected comprised 3195 birds, 971 bats, 372 mammals other than bats, and 408 reptiles and amphibia. The majority of the specimens are deposited in the Smithsonian Institution, with a few others in the British Museum, and the University Museum of Addis Ababa.

Large collections of ectoparasites including ticks, and hippoboscid, streblid and nycteribiid flies were sent to Dr. Hoogstraal in Cairo. Fleas were sent to Dr. Robert Traub, at the Smithsonian Institution.

In a further attempt to obtain information on the general ecology of birds, it is necessary to know where they spend their time feeding in order to assess their availability to various species of ticks and mosquitoes at different times of the day. With this in view, the crop and gizzard contents of over 3000 birds were preserved but these had to be abandoned unstudied, in Ethiopia.

Bird Banding Studies

About half the birds caught alive were marked with sequentially numbered and addressed leg bands. The main purposes of this operation were to:

a.) Individually identify bled birds on subsequent recapture.

b.) Assess age longevity of individuals in the sampled populations.

c.) Obtain information on population turnover in the study area.

d.) Seek data on local movements and intra-African migration of local species.

e.) Trace sources of Palearctic migrants visiting or migrating through the study areas.

At the close of the project in April 1977, a total of 48,995 birds of 494 species had been banded since October 1969. A number of birds banded in Ethiopia have been reported from overseas in Europe and Asia, and others have been found elsewhere in Africa. All European, Asian and Africian national banding schemes were asked to provide data on recoveries in Ethiopia and these, together with those resulting from the present study or by members of the public now total 96. More can be expected from the banded birds which are still alive. Recoveries come from 23 countries (Germany, Poland, Finland, Bulgaria, Yugoslavia, Austria, Denmark, Greece, Hungary, Lithuania, Rumania, Sweden, USSR, Iran, Lebanon, Syria, Kuwait, Saudi Arabia, Kenya, South Africa, Sudan, Mozambique, Uganda) (Fig. 3). At least 32 species are involved in this total, of which 26 are Palearctic immigrants and 6 are of African origin.

Of particular interest ornithologically and in terms of the possible transference and maintenance of arbovirus infections, either from northern regions to the tropics or vice versa, is the number of migrants recurring in the study areas subsequent seasons. Several individuals have occurred in different years, and one bird returned to the same study area in at least its fifth migratory season. Up to the end of 1976, individuals of 28 species had been recorded more than once after intervening return visits to the Palearctic region; there were 87 records of birds on their first known revisit, 39 on their second, 17 on their third, 9 on their fourth and 1 on its fifth.

The thousands of recaptures of local non-migratory banded birds provided a huge amount of data for subsequent study. Included in these are individuals which were bled on several occasions and individuals recaptured up to six years after being first bled; also there are data on which population turn-over rates could be assessed, based on the seasonal relative abundance of recaptured banded birds and newcomers to the area. General analyses of these data are not warranted for this report, but they would be worthwhile at a later stage in the case of individual bird species known to be important in the maintenance, or as amplifiers, of arbovirus reservoirs.

The totals for individual species banded, full details for every recovery reported, and other data, are included in a series of eight reports (Ash, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978).

Population Studies

At an early stage it was judged to be important to obtain an understanding of the natural history of the vertebrate species in each of the study areas. Firstly, it was necessary to obtain an indication of absolute and relative numbers, for clearly a common species with a high potential for being a host of an arbovirus would be more important than either a species in small numbers, but which had a high potential, or an abundant species with a low potential. An estimate of the numbers present within the study area was obtained on each day of every visit from 1970 for all species of birds and larger mammals. This estimate was based on daily transect counts and the numbers of each species captured. When sufficient data became available to list the vertebrate hosts of potential importance, and when there was information on the seasonal incidence of arbovirus activity, valuable information on bird and mammal numbers in the area would be at hand. A detailed analysis of populations and seasonal and annual changes is not justified at present, but one example for a thrush, *Turdus pelios*, a species with high antibody titers and from which viruses were isolated is given in Table 17.

Information on population structure, for a particular sex or age group might be important in a virus transmission cycle. For this reason as far as it was possible, all captured animals were aged and sexed. It was also believed that some measure of condition of the animal might be of some importance in judging whether a particular species was being affected by a virus. Possibly weight could be used as an indication of condition, so samples of every species caught, often very large samples, were weighed. About 40,000 weight are now stored for future reference and study, if required, but in the case of birds these are unlikely to be significant in terms of arboviruses. Daily weight ranges of 35-30% are not uncommon in individual birds and the variation of the weights of individuals about the mean for the species is so great that using weights as a measure of condition is probably valueless. The weights for one species, Streptopelia decipiens are shown in Table 18 as an example of the types of data available.

Copies of all the information obtained for the censuses, weights and seasonal and geographical distribution of animals, involving some 6,000 pages, will be deposited in the archives of the Smithsonian Institution. As time permits various facets of these will be prepared for publication.

Life History and Distribution Studies of Birds

As Dr. Ash travelled in Ethiopia and trapped birds on each of the study areas, new data on life history and distribution were accumulated. Some of this information has already been published in a series of papers (Project Bibliography 1) and more are in process. Dr. Ash anticipates that eventually he will be able to complete the text for a checklist of the birds of Ethiopia to accompany the already completed distribution maps.

Discussion and Conclusions

The initial broad serological survey of vertebrates in Ethiopia has shown that a small field team (one man with an assistant) is able to capture alive and examine at least 1000 animals per month in East Africa. Adequate samples can be obtained for serology with minimum mortality of the vertebrate hosts being bled.

An approach towards elucidating the problem, which of the large numbers of vertebrate species occurring in tropical areas are most likely to be acting as reservoir or amplifying hosts for arboviruses, was successful in a broad serological survey. The serological results indicated the species with high antibody titers, and subsequent sampling of these selected species for virus isolation was providing large numbers of isolates. Unfortunately, just as the field and laboratory study had reached the point of maximum return in terms of virus isolates, it had to be terminated due to the Unit's eviction from Ethiopia, and much of the recently collected and recently processed material had to be abandoned or was lost in Addis Ababa.

The species examined serologically that showed the highest titers were found in the reptiles (2 species), birds (46 species in 21 families), bats (5 species in 2 families) and other mammals (4 species in 3 families). Many of the species involved are widespread in Africa, so that an examination of these would make a good starting point in any further examination of wild vertebrate reservoir hosts to arboviruses in Africa. In addition, their numbers are small enough to be within the capacity of modest laboratory facilities. The isolation of further viruses from these species would create a problem, but this could be mitigated if the large numbers of bird sera retrieved from Ethiopia were tested for, say, Sindbis, Germiston, Tataguine, chikunguaya, Bunyamwera, and Rift Valley fever viruses.

Neutralization testing shows that West Nile virus is widespread in Ethiopia and infects man. From outbreaks in East Africa and Israel it is known to cause widespread fever with a dengue-like disease and encephalitis. Although of no direct concern to the military, yellow fever is shown to be present in its old epidemic axis in the Didessa and upper Omo River systems. In view of the poor results of the Ethiopian vaccination program, yellow fever would still need to be considered in any future outbreak of epidemic hemorrhagic diseases.

From the bird data, it would seem that both Benzi and Wesselsbron viruses may also occur, although they are less prevalent than West Nile. The Ntaya virus antibody may be real since the virus was isolated in Ethiopia by the Institut Pasteur. Zika virus also would seem to be present and infecting humans on occasion, since there are some nonspecific high-titered human sera; also, Zika seems to be associated with the vector systems of yellow fever which are known to exist in Ethiopia. Of these viruses only Wesselsbron causes dengue-like disease, but any of the others will produce febrile conditions, and all will cause antibody patterns very difficult to interpret where they occur as second infections. There is also the possibility that a further, and as yet unknown, Group B virus occurs.

Dengue viruses do not seem to be widespread. Dengue-like disease in Ethiopia may be due to chikungunya or O'Nyong-nyong viruses, and a few HAI positive sera tested by neutralization are protective against them both. This is suggestive of chikungunya, since experimentally produced antisera to this virus protects against O'Nyong-nyong but not visa-versa.

The study had reached a maximum return stage at its forced conclusion. However, much of the technology, experience and information is directly transferable to other studies and could save another laboratory much time in getting into operation. One may but hope that there will soon be another African laboratory to continue the project human arbovirus studied planned for Ethiopia. Should this ever develop, the primary need is for an overall plan and set of objectives to coordinate the roles of the personnel (virologist, entomologist, clinician, zoologist/ecologist) involved, within an agreed practical framework and with particular emphasis on the laboratory facilities necessary to process the blood and other tissue samples. All of these factors were deficient to some degree in Ethiopia, and singularly or collectively militated against an earlier successful conclusion of the project.

Acknowledgments

A number of persons contributed significantly to the success of this project both in the field in Ethiopia and in scientific and administrative capacities in the United States. J. R. Schmidt, then head of NAMRU-5 in Addis Ababa, originally conceived the arbovirus program in Ethiopia and subsequently followed and aided its progress. Harry Hoogstraal suggested that Dr. Ash should put it into operation; and Captain Donald Kent and Arthur J. Emery, Jr., made it administratively possible within NAMRU and ONR. The contract was initially funded through Thomas R. Grayson at the University of Washington, Seattle. Dr. Ash is indebted to David Snow, Derek Goodwin, Malcolm Largen, John Farrand, Jr., Henry Setzer, Brian Robbins, Harry Hoogstraal for help with identifications. Successive heads of the Virology Division at NAMRU-5, Drs. Vance Vorndam, Westley T. Ota, and particularly Dr. Owen L. Wood, processed the material Dr. Ash collected over the years and he is especially indebted to their many technicians notably Mrs. Edeltrout Popp and Mrs. Pamela Berhanu for their help. Suzanne Pamboukian was largely responsible for biological record keeping in Ethiopia, and most of the vertebrate specimens were prepared by Aurora Clidoro, Enanu Haile and Mekuria Ayele.

In the field, Mekuria Ayele provided Dr. Ash long service as a field technician and interpreter. Dr. Ash's thanks also go to the enumerable field assistants and local authorities who provided so much help. In particular, he holds fondest memories for the friendliness and hospitality of the multitudes of Ethiopian people upon whose lives he impinged. He also wishes to thank the following who helped in various ways: Almaz Bennet, Dorothea B. Curcio, Joyce deBass, Dr. James Harwell, Dr. John LaCroix, Dr. Vern Lee, Dr. E. McConnell, P. Neri and Katherine Pruitt, Mary Rowland.

Not least, Dr. Ash's wife and daughter tolerated his long absences from home, and on the occasions they accompanied him did much to increase the productivity of the occasions.

Dr. Watson is grateful to Martha Lanum, Dorothea B. Curcio, David Short, John Beavers, and Dolores Osborn whose administrative assistance at the Smithsonian facilitated scientific work in the field and to Arthur J. Emery of ONR who sustained interest and support for the project for so long.

APPENDIX I.
SERROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B[1] Ref.	Species	Locality	Total Tested	Total +ve[2]	%+ve[2]	Dil[3]	WN[4]	Nt[5]	Z[6]	Log. No.[7]
					Serological results					
	PELECANIDAE									
7	Pelecanus onocrotalus	Shalla	27	0	0					
8	Pelecanus rufescens	Gambela	1	1	100	ND	4	2	4	16434 (a & b)
						1+1	4	0	3	
	PHALACROCORACIDAE									
11	Phalacrocorax carbo	Abiata	1	0	0					
	ANHINGIDAE									
14	Anhinga rufa	Abiata	6	0	0					
		Bulcha	1	0	0					
	ARDEIDAE									
17	Ixobrychus minutus	Abiata	7	0	0					
		Koka	3	2	66.7	1+1	1	0	0	19266
						ND	1	0	0	19305
		Gambela	3	0	0					
18	Ixobrychus sturmii	Koka	1	0	0					
19	Nycticorax nycticorax	Koka	1	0	0					
20	Nycticorax leuconotus	Gambela	2	1	50	1+1	4	0	0	16501
21	Ardeola ralloides	Abiata	17	0	0					
		Koka	2	1	50	ND	1	0	0	19239
		Gambela	4	1	25	1+1	0	2	0	10386
22	Ardeola ibis	Abiata	13	2	15.4	1+1	2	1	1	10509
						1+2	4	3	2	11114
		Koka	2	0	0					
		Aseita	3	2	66.7	ND	3	0	0	17884
						ND	1	0	0	17962
23	Butorides striatus	Abiata	3	0	0					
		Koka	2	2	100	1+1	4	4	4	11669
						ND	3	0	0	15842
		Bahadu	2	0	0					
		Aseita	4	4	100	ND	4	2	0	17293
						ND	0	1	0	17329
						ND	4	4	4	17933
						ND	4	4	3	17934
		Gambela	8	7	87.5	1+1	4	3	2	6724

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS:

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	NT	Z	Log. No.
						1+1	4	4	0	6732
						1+1	4	4	2	10340
						ND	4	4	4	16266
						ND	4	4	3	18805
						ND	4	4	4	18819
						ND	4	4	4	18841
24	Egretta ardesiaca	Abiata	1	0	0					
25	Egretta alba	Abiata	2	0	0					
26	Egretta intermedia	Abiata	1	0	0					
27	Egretta garzetta	Koka	1	0	0					
28	Egretta schistacea	Koka	1	0	0					
29	Ardea cinerea	Abiata	1	0	0					
30	Ardea melanocephala	Gambela	2	1	50	ND	1	0	0	2129
	SCOPIDAE									
34	Scopus unbretta	Aseita	1	1	100	ND	3	0	0	17950
		Gambela	1	1	100	1+2	0	0	3	10448
		Bulcha	2	1	50	1+1	3	0	0	13719
	CICONIIDAE									
37	Ciconia abdimii	Shalla	17	0	0					
41	Leptoptilos crumeniferus	Abiata	1	1	100	ND	4	4	4	15058
	THRESKIORNITHIDAE									
46	Bostrychia hagedash	Gambela	2	0	0					
		Bulcha	1	0	0					
47	Plegadis falcinellus	Abiata	2	0	0					
	PHOENICOPTERIDAE									
50	Phoenicopterus ruber	Abiata	8	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results					
51	Phoenicopterus minor	Abiata	1	0	0					
		Koka	26	1	3.8	ND	0	0	2	19043
	ANATIDAE									
52	Dendrocygna bicolor	Abiata	4	0	0					
53	Dendrocygna viduata	Koka	6	0	0					
		Aseita	4	0	0					
55	Alopechen aegyptiaca	Abiata	15	0	0					
		Koka	7	0	0					
		Bahadu	2	0	0					
		Bulcha	2	0	0					
61	Anas penelope	Koka	1	0	0					
64	Anas capensis	Abiata	11	0	0					
67	Anas acuta	Abiata	3	0	0					
69	Anas hottentota	Abiata	5	0	0					
		Koka	4	0	0					
70	Anas querquedula	Abiata	5	1	20.0	1+3	2	0	0	7180
		Koka	1	0	0					
71	Anas clypeata	Koka	2	0	0					
72	Netta erythrophthalma	Abiata	1	0	0					
	ACCIPITRIDAE									
79	Aviceda cuculoides	Bulcha	2	0	0					
82	Elanus caeruleus	Koka	2	1	50	ND	0	1	0	19195
		Bahadu	1	0	0					
83	Chelictinia riocourii	Kelam	2	1	50	ND	1	0	1	18584
84	Milvus migrans	Bahadu	5	0	0					
		Aseita	3	1	33.3	ND	4	2	1	17961
		Gambela	11	4	36.4	ND	4	4	3	16249
						ND	2	0	0	16250
						ND	2	0	0	16251
						ND	1	0	1	18816

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	NT	Z	Log. No.
						Serological results				
		Didessa	15	5	33.3	1+2	2	0	0	5374
						1+1	3	0	0	11948
						1+1	2	0	0	11950
						1+1	4	4	4	11952
						ND	4	0	0	14288
		Bulcha	14	3	21.4	1+2	2	0	0	13657
						ND	2	0	0	16581
						1+1	2	2	0	18248
		Kelam	1	0	0					
88	Necrosyrtes monachus	Bahadu	1	1	100	1+2	2	0	0	11220
		Didessa	3	0	0					
89	Gyps africanus	Bahadu	1	1	100	ND	2	0	0	18503
97	Terathopius ecaudatus	Bulcha	1	1	100	1+1	2	0	2	7425
99	Circus aeruginosus	Koka	1	0	0					
100	Circus macrourus	Koka	2	1	50	ND	4	4	2	14623
		Bulcha	1	0	0					
101	Circus pygargus	Koka	2	1	50	ND	4	3	3	15546
102	Melierax metabates	Koka	3	1	33.3	ND	4	1	3	19362
		Bahadu	1	0	0					
		Didessa	1	0	0					
		Bulcha	4	4	100	ND	3	2	0	14831
						ND	3	2	2	17652
						1+1	4	4	4	18280
						ND	3	0	2	18314
104	Melierax gabar	Abiata	1	0	0					
		Koka	2	1	50	1+1	4	4	2	12469
		Bahadu	1	1	100	ND	2	3	4	7925
109	Accipiter minullus	Bulcha	7	2	28.6	1+2	3	1	3	7540
						1+1	2	0	0	13618
110	Accipiter tachiro	Aseita	1	0	0					
		Gambela	1	0	0					
		Didessa	2	1	50	ND	4	1	0	16898
		Bulcha	9	4	44.5	1+2	4	0	0	13595
						ND	4	1	2	17570
						1+1	2	0	0	17647
						ND	4	2	3	18272

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	NT	Z	Log. No.
112	Accipiter badius	Koka	1	0	0					
		Bahadu	19	1	5.3	1+3	4	0	0	15392
		Bulcha	7	2	28.6	1+4	0	0	2	7369
						ND	4	2	1	16653
115	Buteo buteo	Aseita	2	0	0					
		Didessa	1	0	0					
129	Lophoaetus occipitalis	Abiata	1	1	100	1+1	2	2	2	6986
		Koka	3	2	66.7	ND	4	4	3	15887
						ND	2	0	1	19198
		Bahadu	1	1	100	ND	2	0	1	18468
		Gambela	1	1	100	ND	4	4	4	16480
		Bulcha	1	1	100	ND	3	2	2	17685 (a & b)
						1+1	4	3	2	
	FALCONIDAE									
138	Falco ardosiaceus	Didessa	1	0	0					
		Bulcha	1	1	100	ND	4	1	2	16696
140	Falco chicquera	Gambela	2	1	50	1+1	4	3	4	18840
142	Falco cuvieri	Koka	1	0	0					
148	Falco peregrinus	Abiata	1	1	100	1+2	1	1	1	7111
	PHASIANIDAE									
152	Francolinus sephaena	Bulcha	13	6	46.2	1+1	0	1	1	7520
						1+1	2	3	4	9554
						1+1	2	4	4	12947
						ND	4	3	3	16730
						1+3	3	4	4	17608
						ND	0	2	0	18256
156	Francolinus clappertoni	Koka	21	2	9.5	1+1	0	0	3	9002
						1+1	2	0	2	12429
		Didessa	2	0	0					
160	Francolinus squamatus	Didessa	1	1	100	1+1	4	4	4	11903
		Bulcha	2	0	0					
161	Coturnix coturnix	Koka	1	0	0					
	NUMIDIDAE									

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
165	Numida meleagris	Abiata	1	0	0					
		Koka	4	1	25.0	1+1	1	3	3	8750
		Bahadu	1	0	0					
	TURNICIDAE									
167	Turnix sylvatica	Koka	1	0	0					
	RALLIDAE									
184	Gallinula chloropus	Didessa	1	0	0					
186	Porphyrio alleni	Gambela	3	0	0					
	JACANIDAE									
198	Actophilornis africana	Koka	1	0	0					
		Gambela	37	1	2.7	1+1	2	0	0	10466
	ROSTRATULIDAE									
200	Rostratula benghalensis	Abiata	2	0	0					
		Koka	5	0	0					
		Gambela	8	2	25.0	1+2	3	4	2	16422
						1+2	2	0	0	
	CHARADRIIDAE									
203	Vanellus spinosus	Abiata	45	2	4.4	1+1	0	2	0	7037
						1+4	0	2	0	7139
		Koka	10	0	0					
		Bahadu	1	0	0					
		Aseita	5	0	0					
		Gambela	2	0	0					
207	Vanellus senegallus	Gambela	2	1	50	ND	4	3	2	16282
		Didessa	2	0	0					
		Bulcha	1	0	0					
211	Pluvialis squatarola	Koka	1	0	0					
212	Charadrius hiaticula	Abiata	13	0	0					
		Koka	22	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
213	*Charadrius dubius*	Abiata	2	0	0					
		Koka	42	1	2.4	1+2	2	3	1	11355
		Gambela	14	0	0					
214	*Charadrius pecuarius*	Abiata	4	0	0					
		Koka	37	0	0					
215	*Charadrius tricollaris*	Koka	22	0	0					
		Bahadu	1	0	0					
216	*Charadrius alexandrinus*	Koka	7	0	0					
		Abiata	1	0	0					
220	*Charadrius asiaticus*	Koka	1	0	0					
	SCOLOPACIDAE									
223	*Limosa limosa*	Abiata	1	0	0					
		Koka	2	1	50	1+1	1	0	0	
225	*Tringa nebularia*	Abiata	11	0	0					
		Koka	2	0	0					
226	*Tringa stagnatilis*	Abiata	48	3	6.2	1+1	2	0	0	6865
						1+1	4	3	2	7031
						1+2	2	0	0	7201
227	*Tringa glareola*	Abiata	49	1	2.0	1+2	1	2	0	6910
		Bahadu	1	1	100	1+2	0	1	0	18480
		Aseita	5	0	0					
		Gambela	2	0	0					
228	*Tringa ochropus*	Abiata	9	1	11.1	1+2	4	1	1	10593
		Koka	12	1	8.3	1+1	4	3	4	19201
		Aseita	1	0	0					
		Didessa	2	0	0					
229	*Tringa hypoleucas*	Abiata	44	0	0					
		Koka	5	0	0					
		Bahadu	3	0	0					
		Aseita	1	0	0					
		Gambela	8	2	25.0	1+1	0	0	1	18692
						1+1	1	0	0	18712
230	*Tringa totanus*	Abiata	11	0	0					
		Koka	6	0	0					

Cont.

SERIOLOGICAL

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
232	Tringa terek	Abiata	5	0	0					
234	Gallinago media	Aseita	1	0	0					
235	Gallinago gallinago	Abiata	49	0	0					
		Aseita	1	0	0					
238	Calidris alpina	Koka	1	0	0					
239	Calidris ferruginea	Abiata	47	0	0					
240	Calidris minuta	Abiata	48	1	2.1	1+3	1	3	4	7091
242	Calidris temminckii	Koka	1	0	0					
242a	Calidris melanotos	Koka	1	0	0					
245	Philomachus pugnax	Abiata	50	0	0					
	RECURVIROSTRIDAE									
246	Himantopus himantopus	Abiata	17	0	0					
		Koka	7	0	0					
247	Recurvirostra avosetta	Abiata	11	0	0					
		Koka	1	0	0					
	BURHINIDAE									
251	Burhinus senegalensis	Abiata	3	0	0					
		Koka	12	3	25.0	ND	0	0	1	7645
						1+1	3	2	4	12388
						ND	1	0	0	15961
		Aseita	2	1	50	ND	4	3	4	17387
		Gambela	12	6	50.0	ND	4	4	4	16472
						ND	4	2	3	17421
						ND	4	3	4	17432
						ND	4	2	4	17519
						ND	4	0	2	18683
						ND	4	4	4	18808
252	Burhinus capensis	Bulcha	3	1	33.3	1+1	4	3	0	14889
	GLAREOLIDAE									

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	NT	Z	Log. No.
						Serological results				
253	Pluvianus aegyptius	Gambela	25	10	40.0	1+1	2	2	1	13974
						1+1	2	0	0	17411
						1+1	3	3	2	17507
						1+1	3	0	2	17509
						1+1	1	0	0	18686
						1+1	2	0	0	18708
						1+2	2	0	1	18749
						1+2	1	0	0	18750
						1+1	1	0	0	18768
						1+1	1	0	0	18775
257	Curosrius cinctus	Koka	2	0	0					
		Bulcha	3	1	33	1+2	2	0	0	18361
259	Glareola pratincola	Koka	2	0	0					
	LARIDAE									
267	Larus ridibundus	Abiata	4	0	0					
269	Larus cirrhocephalus	Abiata	3	0	0					
273	Sterna nilotica	Abiata	1	0	0					
281	Sterna hybrida	Abiata	1	0	0					
282	Sterna leucoptera	Abiata	17	0	0					
	RYNCHOPIDAE									
285	Rynchops flavirostris	Gambela	2	0	0					
	PTEROCLIDIDAE									
287	Pterocles exustus	Koka	17	0	0					
290	Pterocles lichtensteinii	Filwoha	5	2	40.0	1+1	4	4	4	13517
		Aseita	3	1	33.3	1+1	4	1	0	13529
						ND	2	0	1	17906
291	Pterocles quadricinctus	Koka	10	1	10.0	ND	0	1	0	19024
		Bahadu	1	1	100	ND	4	4	4	15368

Cont.

SERABOLOGICAL

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	NT	Z	Log. No.
		Gambela	2	1	50	1+4	2	2	3	17422
	COLUMBIDAE									
294	Columba guinea	Koka	1	1	100	1+1	4	4	4	18161
		Didessa	4	1	25.0	1+1	3	0	0	11899
296	Streptopelia turtur	Koka	2	1	50	1+4	4	4	3	18051
		Aseita	2	0	0					
297	Streptopelia lugens	Koka	9	2	22.2	1+1	4	2	2	12327
						ND	0	1	0	18930
		Bulcha	1	0	0					
		Addis Ababa	45	6	13.4	ND	2	0	0	15466
						ND	0	2	2	15476
						ND	1	0	0	15481
						1+1	0	0	1	15484
						1+1	1	0	0	15487
						1+1	0	0	1	15497
298	Streptopelia semitorquata	Abiata	1	0	0					
		Koka	49	4	8.2	1+1	3	0	0	6122
						1+1	0	1	0	11575
						1+1	4	4	4	11619
						ND	1	0	0	15865
		Gambela	15	6	40.0	ND	4	4	4	13111
						ND	3	3	2	13778
						ND	2	2	2	13982
						ND	2	0	0	13983
						ND	4	4	4	16245
						ND	4	3	3	18711
		Didessa	27	4	14.8	ND	2	0	0	14190
						ND	3	4	4	14286
						ND	4	2	2	14319
						ND	3	2	2	14334
		Bulcha	61	3	4.9	1+1	2	2	3	12040
						ND	0	2	0	14918
						ND	4	4	4	17677
		Addis Ababa	9	0	0					
299	Streptopelia decipiens	Abiata	43	0	0					
		Koka	213	22	10.3	1+1	0	0	3	6123
						1+1	3	3	4	6177
						1+1	3	3	2	11390
						1+1	4	2	3	11439
						1+1	3	2	2	11447
						1+1	4	4	4	12207

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
						Serological results				
						1+1	2	1	1	12303
						1+1	2	4	2	12338
						ND	2	0	0	15547
						ND	3	0	0	15610
						ND	4	0	0	15667
						ND	4	1	3	15692
						ND	3	0	0	15697
						ND	3	3	3	15700
						1+1	3	3	0	15816
						1+4	3	0	2	15837
						ND	3	0	0	15854
						ND	4	2	3	15910
						ND	4	1	2	15917
						ND	4	0	0	15675
						ND	2	0	0	18413
						ND	2	0	0	18420
		Bahadu	124	40	32.2	ND	0	3	3	7752
						ND	0	2	4	7753
						ND	2	3	4	7759
						ND	3	4	4	7763
						ND	4	4	4	7808
						ND	1	2	4	7820
						ND	0	1	3	7862
						ND	0	1	3	7862
						ND	0	2	2	7865
						ND	0	0	3	7896
						ND	2	3	3	7988
						ND	0	1	2	7989
						1+1	1	4	4	11149
						1+1	4	4	4	11157
						1+1	0	4	4	11163
						1+2	2	2	2	11184
						1+1	0	3	0	11186
						1+1	3	4	3	11190
						1+1	0	4	3	11191
						1+1	0	4	4	11192
						1+1	0	3	4	11200
						1+1	2	3	3	11209
						1+1	1	3	3	11250
						1+1	1	4	2	11272
						1+1	3	3	3	11318
						1+1	3	4	4	12642
						1+1	3	3	2	12691
						1+1	2	3	2	13279
						1+1	3	3	2	13308
						ND	2	0	0	13372

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
						ND	2	0	0	13397
						ND	2	0	2	13398
						ND	4	4	4	15308
						ND	3	2	2	15364
						ND	2	2	2	15372
						ND	2	1	2	15373
						ND	0	2	0	15374
						ND	4	4	4	15432
						ND	2	2	2	15433
						ND	3	2	3	15439
		Aseita	117	41	35.0	ND	4	3	3	16003
						1+1	3	0	0	16032
						ND	2	3	3	16075
						1+2	4	3	2	16085
						ND	4	3	3	16103
						ND	3	0	0	16118
						1+1	3	3	3	16124
						ND	3	2	3	16133
						1+1	2	0	0	16134
						1+1	4	4	4	16136
						1+2	1	0	0	16151
						ND	1	0	0	16153
						ND	1	0	0	16158
						1+2	3	4	3	16168
						ND	4	4	4	16177
						ND	3	2	2	16190
						ND	1	0	0	16206
						1+1	4	4	4	16208
						ND	2	1	1	17077
						ND	0	0	1	17124
						ND	1	0	1	17139
						ND	1	0	0	17143
						ND	3	2	1	17144
						ND	0	0	1	17172
						ND	0	0	1	17184
						ND	3	0	0	17208
						ND	2	0	2	17229
						ND	4	2	4	17261
						ND	2	0	3	17288
						ND	3	0	0	17296
						ND	3	0	0	17299
						ND	2	0	4	17315
						ND	2	1	0	17322
						1+1	2	1	0	17354
						ND	4	2	3	17357
						ND	4	4	4	17367
						ND	4	3	4	17386
						ND	4	2	3	17822
						ND	4	4	3	17825

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
						ND	0	0	2	17908
						ND	4	4	2	17921
		Gambela	85	28	32.9	1+1	3	2	0	13136
						1+1	2	2	1	13785
						ND	3	3	3	13814
						ND	2	2	3	13816
						ND	2	2	2	13823
						ND	2	2	2	13825
						ND	1	2	0	13854
						ND	2	0	0	14014
						ND	4	3	3	16231
						ND	2	0	0	16236
						ND	3	0	0	16238
						ND	3	0	0	16239
						ND	2	2	0	16240
						ND	4	2	3	16241
						ND	3	2	2	16382
						ND	3	2	4	16401
						ND	0	0	2	18703
						ND	2	0	0	18731
						ND	2	0	0	18732
						ND	2	0	0	18733
						ND	2	0	0	18739
						ND	2	0	0	18740
						ND	2	0	1	18742
						ND	1	0	0	18762
						ND	1	0	0	18765
						ND	1	0	0	18766
						ND	1	0	0	18778
						ND	2	2	3	18785
		Didessa	1	0	0					
		Kelam	10	8	80.0	ND	2	0	1	18536
						ND	2	0	1	18546
						ND	2	0	0	18558
						ND	0	0	1	18577
						ND	2	0	0	18606
						ND	2	0	0	18610
						ND	2	1	1	18637
						ND	2	0	0	18641
300	Streptopelia vinacea	Gambela	80	24	30.0	1+1	3	3	3	13786
						ND	4	4	4	13810
						ND	3	3	2	13811
						ND	2	3	3	13812
						ND	2	3	2	13813
						ND	3	2	2	13815
						ND	2	2	2	13821
						ND	2	3	2	13824
						ND	4	4	2	13828
						ND	4	4	2	13830

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
						Serological results				
						1+2	4	3	2	13831
						ND	3	3	2	13832
						ND	2	2	2	13856
						ND	2	2	2	13881
						ND	4	2	2	13882
						ND	2	1	0	13948
						ND	3	4	4	16234
						ND	4	4	4	16235
						ND	2	0	0	16242
						ND	2	0	0	16279
						ND	4	4	4	16317
						ND	4	2	3	16378
						1+1	4	4	4	16379
						1+1	2	3	0	17506
		Didessa	24	1	4.2	ND	2	3	3	16958
301	Streptopelia capicola	Abiata	1	0	0					
		Koka	1	1	100	1+2	3	1	2	18901
302	Streptopelia roseogrisea	Bahadu	1	0	0					
		Aseita	31	15	48.4	ND	3	0	2	17140
						ND	2	0	2	17234
						1+1	1	0	0	17260
						ND	2	0	0	17279
						ND	3	1	2	17309
						ND	4	3	2	17313
						ND	4	4	4	17314
						ND	3	2	3	17346
						ND	3	2	3	17404
						ND	4	3	4	17405
						1+1	3	0	0	17877
						1+1	2	0	0	17885
						1+1	4	4	4	17887
						1+1	4	0	0	17890
						1+3	4	3	4	17939
		Dubte	18	2	11.1	1+2	4	4	4	17559
						1+1	3	0	0	17560
303	Streptopelia senegalensis	Abiata	7	0	0					
		Koka	43	0	0					
		Bahadu	4	0	0					
		Aseita	13	0	0					
304	Oena capensis	Abiata	5	0	0					
		Koka	51	9	17.7	1+3	2	2	3	11356
						1+3	2	4	2	11366
						1+4	3	4	3	11411
						1+2	2	1	1	11458

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
						1+2	3	2	2	11514
						1+2	3	3	2	11515
						1+1	0	3	0	11558
						1+2	3	4	3	11603
						1+3	2	2	0	11605
		Bahadu	86	9	10.5	1+2	2	3	4	7768
						1+4	3	0	0	7773
						1+3	1	1	2	7918
						1+1	4	4	4	15351
						1+2	3	2	0	15399
						1+1	0	1	0	15420
						1+2	2	0	0	15421
						1+3	3	2	1	15445
						1+1	4	4	3	15446
		Aseita	13	2	15.4	1+1	1	1	0	17185
						ND	1	0	0	17188
		Gambela	55	20	36.4	1+2	2	0	0	13782
						1+2	4	4	4	13834
						1+2	0	4	0	13874
						1+2	2	3	2	13933
						1+2	3	0	0	13935
						1+2	4	4	4	13940
						1+2	3	4	0	13966
						1+2	4	4	4	14076
						1+4	3	3	2	14088
						1+3	3	2	3	16254
						1+1	4	4	4	16257
						1+1	4	4	4	16258
						1+2	2	4	4	16307
						1+2	1	1	0	16334
						1+2	0	1	1	16356
						1+2	1	1	1	16358
						1+2	4	4	4	16418
						1+2	4	4	4	16428
						1+1	4	4	4	16485
						ND	4	3	3	18771
305	Turtur tympanistria	Koka	19	1	5.3	1+2	1	0	0	19011
		Gambela	7	0	0					
		Didessa	9	0	0					
		Bulcha	49	2	4.1	1+2	2	1	3	13599
						1+2	1	1	1	12953
306	Turtur afer	Koka	13	0	0					
		Bahadu	10	6	60.0	1+1	2	3	3	9298
						1+3	4	4	4	12490
						1+2	3	1	2	12544
						1+3	0	4	4	12553
						1+3	3	4	4	12596
						1+1	3	4	1	15967

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	NT	Z		Log. No.
						Serological results					
		Aseita	46	11	23.9	1+1	4	4	4		15968
						1+1	1	0	0		16018
						1+2	3	1	0		16138
						ND	1	0	1		17093
						ND	1	1	2		17094
						ND	1	0	0		17106
						1+1	0	2	0		17359
						ND	3	0	2		17364
						1+1	4	4	4		17777
						1+2	2	0	1		17846
						1+1	1	2	2		17863
		Gambela	31	4	12.9	1+1	0	0	1		2241
						1+2	0	0	0	YF1	2269
						1+2	0	2	0		10179
						1+1	0	3	0		17427
						1+1	0	1	0		18706
		Didessa	18	1	5.6	1+3	4	4	4		14342
		Bulcha	50	1	2	1+2	1	2	2		9548
						1+1	0	0	0	ONN1	17594
307	*Turtur chalcospilos*	Bulcha	52	4	7.7	1+2	1	0	0		13633
						1+2	4	4	4		12896
						1+1	2	2	3		16736
						1+1	4	4	4		16737
308	*Turtur abyssinicus*	Gambela	21	0	0						
309	*Aplopelia larvata*	Didessa	1	0	0						
		Bulcha	34	0	0						
310	*Treron australis*	Didessa	10	1	10.0	1+1	4	0	0		11850
311	*Treron waalia*	Bahadu	38	10	26.3	1+1	4	4	4		11230
						1+1	4	4	4		11262
						1+2	4	4	4		11267
						1+2	1	0	0		13411
						1+1	4	1	1		18473
						1+2	0	1	0		18484
						1+1	1	1	2		18489
						1+1	0	2	3		18490
						ND	4	2	2		18492
						ND	1	0	0		18514
		Gambela	3	1	33.3	ND	0	2	2		13053
	PSITTACIDAE										
316	*Agapornis taranta*	Abiata	2	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
		Koka	1	0	0					
	MUSOPHAGIDAE									
322	Crinifer zonurus	Didessa	1	1	100	1+1	4	1	3	19171
	CUCULIDAE									
323	Clamator glandarius	Koka	1	0	0					
324	Clamator jacobinus	Koka	1	1	100	1+2	2	0	0	18159
		Bahadu	1	0	0					
		Gambela	1	0	0					
		Bulcha	1	0	0					
325	Clamator levaillantii	Bulcha	2	0	0					
327	Cuculus clamosus	Bulcha	1	0	0					
329	Chrysococcyx klaas	Abiata	2	0	0					
		Koka	5	0	0					
		Bahadu	2	0	0					
		Gambela	1	0	0					
		Bulcha	9	0	0					
330	Chrysococcyx caprius	Abiata	1	0	0					
		Koka	6	0	0					
		Bahadu	7	0	0					
		Gambela	9	0	0					
		Didessa	1	0	0					
334	Centropus monachus	Gambela	7	3	42.8	1+1	3	0	0	2090
						1+1	4	0	0	13115
						1+2	4	2	2	17419
		Didessa	4	1	25.0	1+1	4	3	4	8407
336	Centropus superciliosus	Abiata	1	0	0					
		Koka	8	0	0					
		Bahadu	49	5	10.2	1+3	0	3	0	18493
						1+1	0	0	3	9319
						1+1	1	3	2	11284
						1+1	2	2	0	13253
						1+1	3	4	1	13354
		Kelam	1	1	100	ND	2	0	0	18580
	TYTONIDAE									

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
337	Tyto alba	Abiata	1	0	0					
		Koka	3	0	0					
		Bahadu	2	1	50	1+1	3	0	0	15367
	STRIGIDAE									
338	Otus scops	Koka	5	0	0					
		Filwoha	9	9	100	1+1	4	3	4	13450
						1+2	2	0	1	13451
						1+1	2	0	1	13477
						1+2	3	2	1	13481
						1+1	4	3	2	13482
						1+1	3	3	4	13483
						1+2	4	2	0	13484
						1+1	4	0	2	13532
						1+1	4	4	4	13533
		Bulcha	3	1	33.3	1+1	2	0	0	15036
339	Otus leucotis	Abiata	1	0	0					
		Koka	1	0	0					
		Bahadu	1	1	100	1+2	0	2	2	11251
341	Bubo africanus	Bahadu	1	0	0					
		Didessa	1	1	100	ND	4	3	3	14255
		Bulcha	1	1	100	ND	0	0	2	1861
348	Asio flammeus	Abiata	1	0	0					
	CAPRIMULGIDAE									
350	Caprimulgus europaeus	Abiata	1	0	0					
351	Caprimulgus aegyptius	Koka	1	0	0					
352	Caprimulgus nubicus	Bulcha	1	0	0					
353	Caprimulgus fraenatus	Abiata	2	0	0					
		Bahadu	1	0	0					
		Bulcha	4	0	0					
354	Caprimulgus donaldsoni	Bulcha	1	0	0					
355	Caprimulgus poliocephalus	Abiata	1	0	0					
		Bulcha	1	0	0					
356	Caprimulgus inornatus	Koka	2	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS:

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
						Serological results					
		Bahadu	4	0	0						
		Aseita	4	1	25.0	1+3	2	2	2		17857
		Gambela	1	0	0						
		Didessa	1	0	0						
		Bulcha	3	1	33.3	1+2	2	0	0		12950
359	*Caprimulgus clarus*	Koka	31	0	0						
		Bahadu	48	5	10.4	1+2	0	2	2		8089
						1+2	0	0	1		8104
						1+2	3	4	4		9477
						1+1	0	4	4		11197
						1+4	2	2	2		11263
		Aseita	31	6	19.5	1+2	4	4	4		15984
						1+2	4	4	4		15990
						1+2	1	0	0		16013
						1+2	2	0	1		16144
						1+2	3	4	3		16180
						1+2	4	4	4		16069
		Bulcha	36	1	2.8	ND	0	2	0		1851
360	*Caprimulgus climacurus*	Gambela	10	1	10.0	1+2	4	3	4		17446
361	*Macrodipteryx longipennis*	Gambela	4	0	0						
		Didessa	20	0	0						
	APODIDAE										
365	*Apus niansae*	Koka	1	0	0						
	COLIIDAE										
371	*Colius Striatus*	Koka	50	1	2.0	1+1	2	1	2		9144
		Aseita	5	1	25.0	1+1	4	4	4		16127
		Gambela	53	4	7.5	ND	0	0	1	YF2	2045
						1+1	0	3	2		2270
						1+2	4	4	4		2401
						1+2	2	3	3		13998
		Didessa	25	0	0						
		Bulcha	22	1	4.5	1+5	0	0	0	D4	1771
						1+1	2	1	3		18243
373	*Colius macrourus*	Koka	10	0	0						
		Bulcha	21	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
						Serological results					
	TROGONIDAE										
374	Apaloderma narina	Didessa	1	0	0						
		Bulcha	3	0	0						
	ALCEDINIDAE										
375	Ceryle maxima	Gambela	7	1	14.3	ND	4	0	2		18776
376	Ceryle rudis	Abiata	49	1	2.1	1+1	0	1	4		6987
		Bahadu	9	3	33.3	ND	1	2	3		7913
						1+1	2	4	0		13355
						1+4	0	2	2		18495
		Gambela	49	0	0						
377	Alcedo semitorquata	Didessa	11	1	9.1	1+2	0	0	1		19055
378	Alcedo cristata	Abiata	22	0	0						
		Koka	10	0	0						
		Bahadu	52	0	0						
		Gambela	52	2	3.8	1+3	0	2	0		10163
						1+4	2	4	3		10211
		Didessa	3	0	0						
379	Ceyx picta	Abiata	7	0	0						
		Koka	24	0	0						
		Bahadu	50	3	6.0	1+3	0	2	2		7958
						1+4	3	4	4		11166
						1+4	0	3	0		11202
		Gambela	52	2	3.8	1+2	2	2	2	D2	2619
						1+4	4	3	4		10153
		Didessa	29	0	0						
		Bulcha	45	0	0						
380	Halcyon senegalensis	Abiata	12	0	0						
		Koka	8	0	0						
		Bahadu	49	0	0						
		Gambela	26	0	0						
		Didessa	2	0	0						
		Bulcha	2	1	50	1+2	1	0	0		7284
381	Halcyon chelicuti	Didessa	20	1	5.0	1+2	0	0	1		19060
		Bulcha	6	0	0						
383	Halcyon leucocephala	Abiata	12	1	8.3	1+2	4	4	4		11111

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
		Koka	6	0	0					
		Bahadu	49	0	0					
		Aseita	26	3	11.5	1+1	3	0	0	16017
						1+1	2	0	0	16081
						1+1	3	0	0	16087
		Gambela	28	1	3.6	1+2	1	0	0	
		Didessa	12	0	0					
		Bulcha	1	0	0					
	MEROPIDAE									
385	Merops superciliosus	Abiata	1	0	0					
		Gambela	1	0	0					
387	Merops nubicus	Abiata	55	2	3.6	1+2	3	0	1	10985
						1+2	1	0	0	11013
		Koka	3	0	0					
		Bahadu	67	11	16.4	1+2	4	4	4	5120
						1+3	0	0	2	7982
						1+3	2	2	2	8001
						1+3	2	2	2	8048
						1+2	0	1	1	8109
						1+2	2	0	0	11328
						1+1	2	4	1	13331
						1+1	0	0	1	13334
						1+1	0	3	0	13346
						1+2	2	2	0	15333
						1+2	0	2	0	15335
		Didessa	13	1	7.7	1+2	1	0	1	17059
		Bulcha	15	2	13.3	1+2	0	4	0	15032
						1+2	0	3	0	15033
388	Merops albicollis	Bahadu	20	3	15.0	1+2	0	0	3	9285
						1+2	1	1	0	15283
						1+2	4	4	4	15436
		Aseita	2	1	50	1+2	2	0	0	17792
389	Merops pusillus	Abiata	5	0	0					
		Koka	20	1	5.0	1+4	3	4	3	11556
		Bahadu	36	2	5.6	1+2	0	0	4	4808
						1+4	0	0	2	8081
		Aseita	13	2	15.4	1+3	4	2	3	17845
						1+3	4	4	4	17848
		Gambela	24	3	12.5	1+1	3	4	3	2727
						1+3	0	2	0	10212
						1+3	4	3	3	17426
		Didessa	40	0	0					
		Bulcha	1	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
						Serological results				
390	Merops lafresnayii	Didessa	10	0	0					
		Bulcha	35	2	5.7	1+1	0	0	3	7517
						1+2	0	1	0	18348
392	Merops bulocki	Gambela	13	2	15.4	1+2	4	4	4	16325
						1+2	0	2	0	16415
	CORACIIDAE									
395	Coracias abyssinica	Bahadu	4	1	25.0	ND	3	0	2	8066
398	Eurystomus glaucurus	Bulcha	7	1	14.3	1+2	2	0	0	14946
	UPUPIDAE									
399	Upupa epops	Abiata	1	0	0					
		Koka	23	2	8.3	1+1	4	2	2	11423
						1+2	4	3	3	18064
		Bahadu	13	6	46.2	1+2	2	1	2	7902
						1+2	1	1	1	7950
						1+2	2	4	4	11156
						1+1	0	4	4	11172
						1+1	2	3	4	18504
						1+2	1	1	0	18513
		Aseita	26	6	23.1	1+1	3	4	4	16216
						1+1	0	1	0	17233
						1+1	4	0	2	17883
						1+1	4	2	3	17938
						1+2	4	2	3	17952
						1+1	3	1	2	17963
		Didessa	1	1	100	1+1	2	3	3	11926
	PHOENICULIDAE									
400	Phoeniculus purpureus	Abiata	4	0	0					
		Koka	2	0	0					
		Bahadu	2	0	0					
402	Phoeniculus aterrimus	Koka	3	0	0					
		Bahadu	2	0	0					
		Bulcha	3	0	0					
	BUCEROTIDAE									

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	Serological results %+ve	Dil.	WN	Nt	Z	Log. No.
404	*Tockus nasutus*	Bulcha	6	2	33.3	ND	2	3	3	13714
						ND	0	4	0	13764
405	*Tockus erythrorhynchus*	Abiata	2	0	0					
		Bahadu	3	1	33.3	1+1	4	3	3	12536
406	*Tockus deckeni*	Koka	1	1	100	1+1	3	1	2	11307
		Bulcha	14	1	7.1	1+1	0	4	0	9717
409	*Tockus alboterminatus*	Didessa	1	0	0					
410	*Bycanistes brevis*	Bulcha	1	0	0					
	CAPITONIDAE									
412	*Lybius bidentatus*	Gambela	7	0	0					
		Didessa	5	0	0					
		Bulcha	4	0	0					
413	*Lybius guifsobalito*	Abiata	2	0	0					
		Koka	2	0	0					
		Bahadu	15	1	6.7	ND	0	0	0	7999
		Gambela	27	1	3.7	1+1	1	1	0	13839
		Didessa	6	0	0					
		Bulcha	18	1	5.5	1+2	2	0	0	18386
415	*Lybius undatus*	Didessa	9	0	0					
416	*Lybius melanocephalus*	Bahadu	1	0	0					
417	*Lybius leucomelas*	Koka	24	0	0					
		Bulcha	5	0	0					
418	*Pogoniulus pusillus*	Bahadu	11	0	0					
		Bulcha	50	0	0					
419	*Pogoniulus chrysoconus*	Gambela	1	0	0					
		Didessa	1	0	0					
		Bulcha	3	0	0					
422	*Trachyphonus erythrocephalus*	Bulcha	3	1	33.3	1+1	2	2	3	11985
	INDICATORIDAE									

Cont.

SERROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
423	Indicator variegatus	Bulcha	20	0	0					
424	Indicator indicator	Koka	13	0	0					
		Bahadu	1	0	0					
		Gambela	9	0	0					
		Didessa	8	0	0					
		Bulcha	13	1	7.7	1+1	0	2	0	12908
425	Indicator minor	Koka	6	0	0					
		Gambela	7	1	14.3	1+2	3	3	3	16461
		Didessa	9	0	0					
		Bulcha	17	0	0					
427	Prodotiscus regulus	Bulcha	1	0	0					
	PICIDAE									
430	Campethera nubica	Abiata	5	0	0					
		Koka	12	0	0					
		Bahadu	4	0	0					
		Filwoha	4	1	25.0	1+2	2	0	2	13475
		Gambela	1	0	0					
		Didessa	4	0	0					
		Bulcha	7	0	0					
431	Campethera cailliautii	Didessa	3	0	0					
432	Dendropicos fuscescens	Abiata	4	0	0					
		Aseita	3	0	0					
		Gambela	1	0	0					
		Didessa	8	0	0					
		Bulcha	7	0	0					
435	Mesopicos goertae	Abiata	1	0	0					
		Koka	10	0	0					
		Bahadu	16	1	6.2	1+2	0	3	3	12558
		Gambela	3	0	0					
436	Thripias namaquus	Abiata	4	0	0					
		Koka	1	0	0					
		Bahadu	3	1	33.3	1+1	2	2	2	12548
		Bulcha	2	0	0					
	ALAUDIDAE									

(Serological results: Dil., WN, Nt, Z, Log. No.)

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results					
441	Mirafra rufocinnamomea	Didessa	4	0	0					
456	Eremopteris leucotis	Abiata	2	0	0					
		Koka	30	1	3.3	1+2	4	4	4	18107
	HIRUNDINIDAE									
461	Riparia paludicola	Koka	49	2	4.1	1+4	1	0	0	8685
						1+2	0	2	0	8761
464	Hirundo smithii	Koka	40	1	2.5	1+2	0	2	0	15608
		Bahadu	51	5	9.8	1+4	4	2	3	11024
						1+4	0	0	3	12655
						1+3	0	1	0	18424
						1+3	1	0	0	18432
						1+2	1	0	0	18469
		Gambela	18	1	5.5	1+3	4	4	4	16271
		Didessa	38	2	5.3	1+3	0	0	2	6322
						1+4	2	0	0	16974
465	Hirundo aethiopica	Koka	3	0	0					
		Bahadu	10	0	0					
		Gambela	2	0	0					
467	Hirundo senegalensis	Didessa	2	0	0					
468	Hirundo daurica	Gambela	1	0	0					
		Didessa	9	1	11.1	1+2	4	0	0	6457
469	Hirundo abyssinica	Didessa	19	0	0					
		Bulcha	1	0	0					
470	Hirundo griseopyga	Gambela	1	0	0					
474	Psalidoprocne pristoptera	Didessa	10	0	0					
		Bulcha	5	0	0					
	MOTACILLIDAE									
476	Motacilla flava	Gambela	1	0	0					
		Bulcha	4	0	0					
478	Motacilla clara	Didessa	2	0	0					
480	Motacilla aguimp	Koka	13	0	0					
		Gambela	6	0	0					
		Didessa	2	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	Serological results %+ve	Dil.	WN	Nt	Z		Log. No
482	Anthus novaeseelandiae	Abiata	3	0	0						
		Koka	51	3	5.9	1+2	0	0	2		8612
						1+2	0	0	1		8891
						1+2	0	0	2		9060
483	Anthus leucophrys	Koka	9	0	0						
		Bahadu	1	0	0						
		Didessa	5	0	0						
486	Anthus trivialis	Didessa	2	0	0						
	CAMPEPHAGIDAE										
492	Campephaga phoenicea	Koka	2	0	0						
		Gambela	1	0	0						
		Didessa	4	0	0						
		Bulcha	63	2	3.2	ND	0	1	1		1615
						ND	3	3	3		1907
493	Campephaga flava	Bulcha	1	0	0						
	PYCNONOTIDAE										
494	Pycnonotus barbatus	Abiata	2	0	0						
		Koka	34	2	5.9	1+2	0	0	2		12283
						1+2	1	0	1		18951
		Bahadu	77	0	0						
		Gambela	51	1	2.0	1+1	0	0	2		2133
		Didessa	49	0	0						
		Bulcha	55	2	3.6	ND	3	3	3	YF2	1512
						1+1	0	2	0		11966
496	Chlorocichla flavicollis	Didessa	13	0	0						
497	Phyllastrephus strepitans	Bulcha	46	1	2.2	ND	0	2	0		1548
	LANIIDAE										
498	Eurocephalus ruppelli	Abiata	2	0	0						
		Koka	3	0	0						
		Bulcha	13	0	0						
499	Prionops plumata	Bulcha	28	2	7.1	ND	1	2	2		1530
						ND	2	1	0		1543
500	Nilaus afer	Koka	9	2	22.2	1+2	4	4	4		18114
						1+2	4	3	4		18144

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
		Bulcha	2	1	50	1+2	4	2	3	17745
502	Dryoscopus gambensis	Abiata	2	1	50	1+1	2	2	0	10860
		Koka	1	1	100	ND	2	0	0	19214
		Didessa	6	2	33.3	1+2	4	4	4	6413
						1+1	4	3	2	16800
		Bulcha	34	21	61.7	ND	2	3	2	1562
						ND	2	2	2	1622
						ND	0	0	1	1639
						1+2	2	1	1	7306
						1+2	3	4	3	7325
						1+1	0	0	2	7477
						1+1	2	1	2	12879
						1+2	4	4	4	12886
						1+2	2	0	0	12910
						1+2	4	4	4	13637
						1+2	3	3	4	14992
						1+1	4	2	4	16566
						1+1	4	4	4	16582
						1+1	4	4	4	16718
						1+1	3	1	3	17626
						1+1	3	0	1	17681
						1+2	4	2	4	18220
						1+1	2	2	0	18245
						1+1	4	4	4	18355
						1+1	3	3	4	18376
						ND	2	2	4	18395
503	Tchagra minuta	Didessa	11	0	0					
505	Tchagra senegalla	Koka	11	1	9.1	1+1	4	2	2	11636
		Filwoha	1	1	100	1+2	3	1	0	13470
		Aseita	3	3	100	1+1	3	0	0	15965
						1+2	4	1	0	16184
						1+1	4	2	2	17850
		Gambela	4	1	25.0	1+1	2	1	2	10382
		Didessa	14	2	14.3	1+1	2	0	0	5180
						1+2	0	0	2	8392
		Bulcha	12	2	16.7	1+2	2	0	0	12998
						1+1	1	0	2	16742
508	Laniarius aethiopicus	Koka	28	2	10.7	1+1	4	3	3	11486
						1+2	2	0	3	18986
						1+1	4	4	3	15889
		Bahadu	3	0	0					
		Didessa	4	1	25.0	1+1	4	2	2	16982
		Bulcha	22	3	13.6	1+1	2	2	3	9628
						1+1	3	0	0	16601
						1+1	2	2	2	16613
509	Laniarius erythrogaster	Gambela	4	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

						Serological results					
U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
510	Laniarius funebris	Koka	10	1	10.0	1+2	1	0	0		18969
		Bulcha	51	12	23.1	1+2	0	1	1		7326
						1+2	3	4	4		12053
						1+1	1	0	0		12883
						1+1	2	2	0		12884
						ND	0	1	1		1585
						1+5	2	2	1		1748
						ND	4	4	4	YF1	1966
						1+1	1	0	2		16744
						1+1	4	0	0		17663
						1+2	2	2	0		18319
						1+2	1	0	0		18366
						1+2	1	0	0		18392
511	Malaconotus sulfureopectus	Koka	28	1	3.6	1+2	2	0	0		18908
		Bahadu	1	0	0						
		Bulcha	46	4	8.7	1+3	0	3	0		14719
						1+2	0	2	0		18335
						1+2	0	2	0		18356
						1+2	2	0	0		18365
512	Malacanotis blanchoti	Bulcha	6	2	33.3	ND	4	3	4		16781
						1+1	0	1	0		18250
513	Lanius collurio	Koka	1	0	0						
		Bulcha	1	0	0						
516	Lanius excubitorius	Abiata	22	1	4.5	1+1	2	1	2		19006
		Koka	18	0	0						
519	Lanius collaris	Didessa	8	0	0						
521	Lanius nobicus	Bulcha	1	0	0						
	MUSCICAPIDAE (TURDINAE)										
523	Saxicola rubetra	Bulcha	1	0	0						
524	Saxicola torquata	Bulcha	1	0	0						
525	Oenanthe oenanthe	Bulcha	1	0	0						
527	Oenanthe pleschanka	Bulcha	4	0	0						
531	Oenanthe isabellina	Bulcha	3	1	33.3	ND	0	4	1		1856
534	Oenanthe bottae	Abiata	1	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

						Serological results					
U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
538	*Cercomela familiaris*	Koka	1	0	0						
		Didessa	13	3	23.1	1+4	0	0	3		8329
						1+3	0	0	2		6242
						1+4	2	0	0		10089
		Bulcha	1	0	0						
540	*Myrmecocichla cinnamomoeiventris*	Didessa	3	0	0						
544	*Monticola saxatilis*	Bulcha	1	0	0						
546	*Monticola rufocinerea*	Didessa	2	0	0						
549	*Cercotrichas podobe*	Bahadu	4	0	0						
551	*Cercotrichas leucophrys*	Bulcha	2	0	0						
552	*Cichladusa guttata*	Bulcha	2	1	50	ND	1	0	1	YF1 D1	1893
553	*Cossypha natalensis*	Bulcha	40	0	0						
554	*Cossypha semirofa*	Koka	12	0	0						
		Didessa	24	1	4.2	1+2	3	0	0		9800
		Bulcha	27	1	3.7	ND	3	3	2	YF2	1590
555	*Cossypha heuglini*	Bulcha	50	2	4.0	1+2	1	0	0		18360
						1+2	2	0	0		18377
557	*Cossypha niveicapilla*	Gambela	14	1	7.1	1+1	1	0	0		18718
		Didessa	20	0	0						
558	*Luscinia megarhynchos*	Koka	1	0	0						
		Gambela	2	0	0						
559	*Luscinia luscinia*	Bulcha	1	1	0	ND	0	4	0		1546
563	*Turdus pelios*	Abiata	10	3	30.0	1+2	2	0	0		10748
						1+1	1	1	0		10961
						1+1	4	4	4		11094
		Koka	42	9	21.4	1+1	3	0	0		11643
						1+1	3	0	0		15582
						1+1	2	0	0		18037
						ND	2	0	0		18890
						1+1	3	2	3		18100
						ND	4	1	1		18926
						ND	1	0	0		19215
						ND	0	0	1		18987
						ND	0	0	1		19360
											Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
						Serological results					
		Bahadu	1	0	0						
		Gambela	139	63	45.3	1+1	4	3	3		2284
						1+2	4	4	4		2333
						1+1	3	3	2		2344
						1+2	4	4	4		2377
						1+2	0	0	2		2393
						1+2	1	2	1		2399
						1+1	3	3	2		2034
						1+1	1	1	0		2079
						1+1	3	3	1		2092
						1+1	0	3	0		2100
						1+1	4	3	2		2112
						1+1	4	4	3		2188
						1+1	4	4	2		2194
						1+1	3	2	2		2252
						1+2	3	1	2		2400
						1+3	2	2	2	YF2	2614
						1+2	0	0	3		2631
						1+2	3	3	4		2643
						1+2	3	3	3		10130
						1+1	4	4	4		10131
						1+5	4	2	2		10132
						1+1	0	0	3		10133
						1+1	3	0	4		10197
						1+2	0	0	4		10367
						1+2	2	1	2		10406
						1+2	3	2	0		10407
						1+2	0	2	0		10449
						1+2	1	2	1		10450
						ND	2	0	2		13024
						ND	2	2	0		13044
						1+1	4	0	0		13056
						ND	4	3	3		13058
						ND	4	4	4		13059
						1+1	1	1	0		13062
						ND	0	0	1		13065
						1+1	4	2	0		13075
						ND	4	1	0		13100
						1+1	3	1	0		13120
						ND	2	1	0		13121
						1+1	4	2	4		13203
						1+1	4	0	0		13204
						1+1	4	3	2		13221
						1+1	4	3	0		13817
						ND	3	0	0		13927
						1+1	4	4	4		14032
						1+1	1	0	0		14078
						1+1	1	0	0		14086
						ND	4	3	0		14081
						ND	4	4	4		16230

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z		Log. No.
						ND	3	2	0		16308
						1+1	4	3	4		16403
						1+2	2	1	2		16432
						1+1	3	1	0		16433
						ND	3	0	4		16453
						1+1	4	4	2		16464
						1+1	4	1	1		16469
						1+1	4	2	1		16470
						ND	4	2	4		17511
						ND	2	1	1		18668
						1+1	2	1	0		18684
						ND	3	1	2		18729
						ND	3	1	2		18791
						ND	2	1	0		18832
		Didessa	49	20	40.8	1+1	0	1	1		3619
						1+1	4	4	4		3686
						1+1	4	4	4		3747
						1+1	2	1	1		5245
						1+5	3	2	2		8366
						1+1	3	2	3		9912
						1+2	2	1	1		10056
						1+1	4	4	3		14193
						1+1	4	0	0		16789
						ND	3	0	1		16873
						ND	1	0	0		16927
						ND	2	1	2		16931
						1+1	2	0	1		17005
						ND	4	2	4		17008
						ND	2	0	0		17010
						ND	3	1	2		17052
						ND	4	4	4		17053
						1+1	3	0	1		19118
						ND	0	1	0		19132
						1+1	3	1	2		19136
		Bulcha	106	54	50.9	ND	0	2	0		1552
						ND	0	1	1		1563
						1+5	4	4	3		1731
						1+5	4	4	2		1750
						ND	0	0	0	YF1	1810
						ND	1	1	0		1876
						ND	3	4	4	YF1 D2	1938
						ND	0	1	2		1939
						ND	1	1	2	YF1	1972
						ND	2	3	1	YF1	1983
						1+2	1	4	2		7336
						1+1	2	2	2		7363
						1+2	0	0	2		7404
						1+4	3	4	4		7480
						1+1	4	2	2		9560

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
						1+1	4	3	1	13620
						ND	0	1	0	13634
						ND	2	2	2	13692
						ND	2	2	1	13744
						1+2	2	3	0	12788
						1+1	4	4	4	12932
						1+1	2	2	3	12982
						ND	4	4	4	14698
						1+1	4	2	2	14793
						1+1	3	2	2	14796
						1+1	1	0	0	14835
						1+1	3	2	2	14849
						1+1	2	2	3	14859
						1+1	3	2	0	14892
						1+1	4	3	0	14928
						1+1	4	3	3	14954
						ND	2	2	0	14960
						1+1	4	2	3	15001
						1+1	1	0	0	15006
						ND	1	0	0	16548
						1+2	2	1	1	16589
						ND	4	4	4	16643
						1+1	4	2	4	16669
						ND	4	4	4	16709
						ND	4	0	0	16725
						ND	3	0	1	16729
						1+1	2	0	0	16746
						1+1	2	0	2	16748
						ND	4	3	3	16747
						1+2	2	0	2	17601
						1+2	4	1	3	17614
						1+1	1	4	3	17665
						ND	2	0	0	18271
						ND	2	0	0	18276
						ND	4	2	3	18284
						ND	4	2	3	18303
						ND	4	2	3	18310
						ND	2	0	1	18339
						1+2	2	0	2	18364
						ND	2	0	1	18394
564	Turdus olivaceus	Abiata	1	1	100	1+2	0	0	1	10504
		Bulcha	19	9	47.4	1+1	4	3	0	14884
						ND	0	1	0	1486
						ND	3	3	0	1500
						ND	2	3	0	1503
						ND	3	3	1	1592

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
						ND	2	0	1	13696
						ND	4	2	3	16541
						ND	3	2	2	16694
						ND	4	4	4	18351
		Addis Ababa	2	0	0					
567	Turdus piaggiae	Bulcha	2	0	0					
	MUSCICAPIDAE (TIMALIINAE)									
568	Alcippe abyssinica	Bulcha	1	0	0					
574	Turdoides leucopygius	Didessa	7	1	14.3	1+1	0	0	2	11920
		Bulcha	9	0	0					
576	Turdoides rubiginosus	Abiata	1	0	0					
		Koka	34	0	0					
		Bahadu	15	2	13.3	ND	0	0	2	7976
						1+2	2	3	3	12516
		Aseita	6	2	33.3	1+2	2	0	0	17809
						1+1	3	0	0	17861
		Bulcha	39	2	5.1	1+2	2	2	2	18359
						ND	1	0	0	1489
	MUSCICAPIDAE (SYLVIINAE)									
578	Bradypterus baboecola	Gambela	1	0	0					
579a	Bradypterus alfredi	Bulcha	2	0	0					
581	Locustella luscinioides	Bahadu	2	0	0					
585	Acrocephalus palustris	Gambela	1	0	0					
		Bulcha	1	0	0					
586	Acrocephalus scirpaceus	Bahadu	2	0	0					
		Gambela	1	0	0					
588	Acrocephalus arundinaceus	Gambela	1	0	0					
589	Acrocephalus baeticatus	Koka	1	0	0					
590	Acrocephalus gracilirostris	Bahadu	50	0	0					
		Gambela	1	0	0					
591	Chloropeta natalensis	Didessa	9	1	11.1	1+4	0	2	2	14094

Cont.

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ECOLOGICAL RELATIONSHIPS BETWEEN ARBOVIRUSES, ECTOPARASITES AND--ETC(U)
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SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	NT	Z		Log No.
					Serological results						
592	Sphenoeacus mentalis	Gambela	2	0	0						
		Didessa	7	1	14.3	1+1	1	0	1		19155
599	Sylvia borin	Bulcha	1	0	0						
600	Sylvia atricapilla	Bulcha	37	1	2.7	1+1	2	0	0		1915
						ND	0	0	0	D2 SF2	1991
601	Sylvia communis	Koka	1	0	0						
		Bulcha	17	1	5.9	1+3	3	0	0		
602	Sylvia curruca	Koka	1	0	0						
		Bulcha	1	0	0						
605	Sylvia mystacea	Koka	1	0	0						
		Bahadu	2	0	0						
608	Phylloscopus collybita	Koka	1	0	0						
611	Cisticola erythrops	Koka	14	0	0						
		Gambela	46	4	8.7	1+3	4	0	0		2039
						1+4	0	2	0		13027
						1+5	3	3	2		13994
						1+3	0	0	4		16452
		Didessa	50	2	4.0	1+3	0	1	2		8367
						1+3	3	2	2		10048
		Bulcha	4	0	0						
613	Cisticola chiniana	Abiata	10	0	0						
		Koka	54	1	1.9	1+3	0	0	1		8841
		Bahadu	54	4	7.4	1+2	0	3	0		4907
						1+2	0	0	1		4985
						1+4	2	4	3		7951
						1+5	1	1	2		8086
		Bulcha	34	1	2.9	1+3	0	4	0		14709
614	Cisticola galactotes	Gambela	16	1	6.2	1+5	0	1	0		13101
616	Cisticola natalensis	Gambela	2	0	0						
		Didessa	26	0	0						
620	Cisticola brachyptera	Gambela	13	0	0						
		Didessa	50	1	2	1+4	0	0	4		8345
622	Cisticola juncidis	Koka	1	0	0						
		Bahadu	5	0	0						
627	Prinia subflava	Abiata	9	0	0						
		Koka	33	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
		Gambela	24	0	0						
		Didessa	37	1	2.7	1+2	2	4	4		3771
629	Heliolais erythroptera	Gambela	1	0	0						
		Didessa	1	0	0						
633	Phyllolais pulchella	Abiata	5	0	0						
		Koka	28	0	0						
		Bulcha	6	0	0						
634	Camaropter brevicaudata	Abiata	4	0	0						
		Koka	57	1	1.8	1+1	0	0	3		11651
		Bahadu	44	1	2.3	1+4	3	4	4		11151
		Filwoha	8	1	12.5	1+5	4	4	3		13478
		Gambela	15	0	0						
		Didessa	36	0	0						
		Bulcha	37	5	13.5	ND	1	2	0		1497
						ND	1	1	0		1507
						ND	3	3	1		1560
						ND	3	3	3	YF2	1633
						1+5	0	3	2		1814
636	Eremomela icteropygialis	Abiata	1	0	0						
		Koka	6	0	0						
638	Eremomela canescens	Didessa	6	0	0						
		Bulcha	2	0	0						
639	Sylvietta brachyura	Bahadu	14	0	0						
		Aseita	20	2	10.0	1+3	2	0	0		17222
						1+3	4	3	3		17800
		Gambela	5	0	0						
		Didessa	11	3	27.3	1+2	2	2	2		5247
						1+5	1	1	1		11913
						1+4	0	2	2		14208
		Bulcha	1	0	0						
640	Syvietta whytii	Abiata	4	0	0						
		Koka	23	0	0						
		Bulcha	34	1	2.9	1+4	3	3	2		11974
	MUSCICAPIDAE (MUSCICAPINAE)										
646	Muscicapa adusta	Didessa	8	1	12.5	1+2	2	3	0		2892

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	Serological results %+ve	Dil.	WN	Nt	Z		Log. No.
647	*Myioparus plumbeus*	Bulcha	8	1	12.5	1+4	3	1	1		16701
650	*Melaenornis edolioides*	Koka	19	0	0						
		Didessa	17	0	0						
		Bulcha	21	2	9.5	ND	3	3	3	YF2	1519
						1+2	2	2	3		12826
652	*Bradornis microrhynchus*	Koka	1	0	0						
		Abiata	3	0	0						
653	*Bradornis pallidus*	Gambela	6	0	0						
		Didessa	18	0	0						
654	*Hyliota flavigaster*	Gambela	1	0	0						
		Didessa	2	0	0						
655	*Batis orientalis*	Koka	8	1	12.5	1+2	3	0	0		18867
		Didessa	5	2	40.0	1+3	4	1	2		16822
						1+3	2	0	1		6258
		Bulcha	8	0	0						
657	*Batis minor*	Koka	4	1	25.0	1+4	2	0	0		8923
		Didessa	4	0	0						
		Bulcha	10	2	20.0	1+2	1	0	0		1796
						1+3	4	4	4		17610
658	*Platysteira cyanea*	Koka	2	2	100	1+4	2	0	0		12239
						1+3	1	0	0		18936
		Didessa	4	0	0						
		Bulcha	42	2	4.8	1+4	3	0	0		16668
						1+3	2	0	0		18215
660	*Terpsiphone viridis*	Koka	22	0	0						
		Abiata	1	0	0						
		Bahadu	35	1	2.8	1+4	2	3	4		7903
		Gambela	24	1	4.2	1+2	0	0	1	SF1 D1	2665
		Didessa	17	0	0						
		Bulcha	29	1	3.4	1+3	2	0	0		18221
	PARIDAE										
662	*Parus leucomelas*	Abiata	3	0	0						
		Gambela	5	0	0						
	NECTARINIIDAE										

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
667	Anthreptes orientalis	Bulcha	4	0	0					
668	Anthreptes collaris	Bulcha	53	1	1.9	1+5	4	4	4	7394
670	Anthreptes metallicus	Bahadu	49	4	8.2	1+5	2	2	2	11137
						1+1	2	3	1	13351
						1+4	2	0	0	15263
						1+3	3	0	0	15280
671	Nectarinia olivacea	Bulcha	20	0	0					
673	Nectarinia senegalensis	Gambela	14	1	7.1	1+5	1	1	1	13089
		Didessa	29	5	17.2	1+3	3	1	0	19061
						1+3	0	2	0	19091
						1+3	0	1	0	19116
						1+3	1	0	0	19145
						1+3	0	1	0	19166
		Bulcha	9	1	11.0	1+2	1	1	0	18285
675	Nectarinia venusta	Koka	1	0	0					
		Gambela	2	0	0					
		Didessa	10	0	0					
		Bulcha	1	0	0					
678	Nectarinia mariquensis	Koka	47	0	0					
		Aseita	1	0	0					
		Bulcha	18	0	0					
679	Nectarinia habessinica	Koka	13	0	0					
		Bahadu	41	3	7.3	1+3	3	0	0	15418
						1+3	4	2	3	15449
						1+3	0	1	0	15361
		Aseita	11	3	27.3	1+3	4	2	2	17142
						1+3	2	0	0	17190
						1+4	4	2	4	17226
680	Nectarinia cuprea	Gambela	33	0	0					
		Didessa	45	0	0					
683	Nectarinia pulchella	Abiata	8	0	0					
		Koka	54	0	0					
		Bahadu	54	0	0					
		Gambela	6	0	0					
		Bulcha	45	0	0					
	ZOSTEROPIDAE									
687	Zosterops abyssinica	Didessa	48	0	0					
		Bulcha	1	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
688	Zosterops abyssinica	Gambela	51	2	3.9	1+2	1	2	0	2232
						1+2	0	0	0	2236
						1+5	2	0	0	13955
	EMERIZIDAE									
695	Emberiza forbesi	Gambela	1	0	0					
		Didessa	7	1	14.3	1+2	1	0	0	19152
696	Emberiza tahapisi	Didessa	33	0	0					
		Bulcha	1	0	0					
	FRINGILLIDAE									
698	Serinus mozambicus	Gambela	52	1	1.9	1+2	4	4	3 D1	2409
						1+2	0	0	0 D1	2582
		Didessa	50	0	0					
		Bulcha	20	0	0					
699	Serinus atrogularis	Koka	38	0	0					
		Bulcha	11	0	0					
700	Serinus leucopygius	Gambela	12	2	16.7	1+2	0	0	4	2700
						1+5	0	1	0	13063
702	Serinus dorsostriatus	Koka	32	0	0					
705	Serinus citrinelloides	Koka	51	0	0					
		Gambela	1	0	0					
		Didessa	50	2	4.0	1+4	0	0	4	9845
						1+3	0	3	0	9864
708	Serinus tristriatus	Addis Ababa	1	0	0					
709	Serinus reichardi	Gambela	1	0	0					
		Didessa	2	0	0					
	ESTRILDIDAE									
710	Vidua macroura	Koka	5	0	0					
		Bahadu	1	0	0					
		Aseita	13	1	7.6	1+2	0	0	3	17859
		Gambela	50	0	0					
		Didessa	31	0	0					
713	Vidua paradisaea	Didessa	16	1	6.2	1+3	0	0	2	17015

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results					
715	Hypochera chalybeata	Abiata	1	0	0					
		Koka	8	1	12.5	1+3	3	2	3	11550
		Bahadu	1	0	0					
		Aseita	48	3	6.2	1+3	0	4	0	17132
						1+3	0	4	0	17194
						1+3	2	0	0	17262
		Gambela	16	1	6.2	1+4	0	0	4	13155
		Didessa	16	0	0					
716	Mandingoa nitidula	Didessa	6	0	0					
		Bulcha	33	0	0					
718	Amadina fasciata	Abiata	3	0	0					
		Koka	11	0	0					
		Aseita	1	0	0					
721	Pytelia phoenicoptera	Gambela	29	3	10.3	1+4	1	0	0	13091
						1+4	0	1	3	13106
						1+4	0	0	1	13172
		Didessa	48	0	0					
723	Estrilda paludicola	Gambela	50	0	0					
		Didessa	63	0	0					
		Bulcha	8	0	0					
724	Estrilda rhodopyga	Abiata	13	0	0					
		Koka	38	0	0					
		Bahadu	7	0	0					
		Bulcha	1	0	0					
726	Estrilda astrild	Gambela	14	0	0					
		Didessa	5	0	0					
727	Estrilda erythronotos	Bulcha	1	0	0					
728	Uraeginthus ianthinogaster	Bulcha	19	1	5.3	1+3	1	0	0	18222
729	Uraeginthus bengalus	Abiata	21	0	0					
		Koka	30	1	3.3	1+3	2	2	1	11554
		Gambela	25	0	0					
		Bulcha	49	0	0					
731	Lagonosticta larvata	Gambela	14	0	0					
		Didessa	48	0	0					
732	Lagonosticta rufopicta	Gambela	44	0	0					
		Didessa	10	1	10.0	1+5	2	2	0	14116
733	Lagonosticta senegala	Abiata	12	0	0					
		Koka	15	0	0					
		Bahadu	39	1	2.6	1+5	4	0	0	12535

Cont.

SERIOLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
		Filwoha	10	0	0					
		Gambela	1	0	0					
		Didessa	7	0	0					
		Bulcha	32	0	0					
734	Lagonosticta rhodopareia	Gambela	7	0	0					
		Didessa	14	0	0					
		Bulcha	6	0	0					
735	Lagonosticta rubricata	Didessa	46	0	0					
		Bulcha	22	0	0					
736	Amandava subflava	Didessa	6	0	0					
738	Lonchura malabarica	Bahadu	16	1	6.2	1+3	0	1	0	18426
740	Lonchura fringilloides	Didessa	3	0	0					
741	Lonchura bicolor	Bulcha	9	0	0					
742	Lonchura cucullata	Gambela	50	1	2	1+2	3	2	3	2243
		Didessa	50	0	0					
		Bulcha	19	0	0					
	PLOCEIDAE									
743	Amblyospiza albifrons	Gambela	27	1	3.7	1+1	0	0	2	18759
		Didessa	9	1	11.1	1+1	0	0	2	8209
		Bulcha	9	1	11.1	1+2	3	4	0	18357
744	Ploceus baglafecht	Didessa	54	1	1.9	1+2	2	0	0	16803
		Addis Ababa	1	0	0					
745	Ploceus puteolus	Koka	50	1	2.0	1+2	0	2	0	15598
		Bahadu	45	1	2.2	1+3	4	4	4	11150
		Gambela	8	0	0					
		Bulcha	10	0	0					
747	Ploceus galbula	Abiata	1	0	0					
		Koka	52	2	3.8	ND	0	0	2	7665
						ND	0	0	1	7672
		Bahadu	55	3	5.7	ND	0	0	2	7797
						ND	0	0	2	7798
						1+2	0	0	2	8085
748	Ploceus taeniopterus	Gambela	73	4	5.5	1+1	0	1	0	2022
						1+1	0	1	0	2124
						1+1	0	0	1	2128
						1+1	0	4	0	2087

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results					
		Bulcha	46	3	6.5	1+3	0	2	0	14693
						1+1	0	2	1	16655
						ND	0	0	1	1964
749	Ploceus intermedius	Abiata	21	0	0					
		Koka	33	0	0					
		Bahadu	51	0	0					
		Bulcha	49	2	4.1	1+3	0	3	0	14882
						1+2	2	4	2	14907
750	Ploceus velatus	Bulcha	55	0	0					
751	Ploceus spekei	Abiata	8	0	0					
752	Ploceus cucullatus	Koka	50	0	0					
		Bahadu	54	1	1.9	1+1	3	3	4	4858
		Gambela	50	0	0					
		Didessa	52	0	0					
755	Ploceus rubiginosus	Abiata	41	1	2.4	1+1	0	2	0	10675
		Koka	4	0	0					
756	Ploceus superciliosus	Gambela	7	0	0					
		Didessa	50	1	2.0	1+3	0	1	0	9813
757	Ploceus ocularis	Abiata	1	0	0					
		Koka	49	2	4.1	1+2	0	1	0	8527
						1+2	4	4	4	15870
		Didessa	6	0	0					
		Bulcha	54	3	5.6	ND	3	2	2	1614
						1+2	0	0	1	7551
						1+2	3	0	0	12952
758	Ploceus nigricollis	Gambela	9	0	0					
759	Malimbus rubriceps	Abiata	1	0	0					
		Bulcha	12	0	0					
760	Quelea cardinalis	Abiata	1	0	0					
		Gambela	1	0	0					
761	Quelea erythrops	Gambela	51	0	0					
		Didessa	58	0	0					
762	Quelea quelea	Koka	64	0	0					
		Bahadu	51	1	2.0	1+1	0	1	1	4969
		Gambela	3	0	0					
		Didessa	1	0	0					
763	Euplectes afer	Koka	5	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

					Serological results						
U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
		Bahadu	13	1	7.7	1+4	3	4	4		11206
		Gambela	12	0	0						
764	Euplectes albonotatus	Abiata	23	0	0						
		Koka	3	0	0						
765	Euplectes ardens	Gambela	4	0	0						
		Didessa	47	3	6.4	1+1	4	3	2		5338
						1+4	0	0	3		8311
						1+3	1	2	2		8331
766	Euplectes axillaris	Gambela	17	0	0						
		Didessa	1	0	0						
768	Euplectes gierowii	Gambela	4	1	25.0	1+2	3	3	0		10440
		Didessa	53	2	3.8	1+2	0	2	0		14174
						1+2	0	0	1		19068
769	Euplectes hordeaceus	Gambela	76	2	2.6	1+2	3	2	3		5962
						1+1	3	0	0		5963
		Didessa	9	0	0						
770	Euplectes macrourus	Gambela	24	1	4.2	1+3	0	0	2		10202
		Didessa	18	1	5.6	1+2	3	2	2		14360
771	Euplectes franciscanus	Koka	50	0	0						
		Bahadu	49	2	4.1	1+2	0	4	0		4914
						1+1	0	0	0	YF1 D1	5023
						1+2	0	2	0		
		Gambela	53	1	1.9	1+1	4	0	0		5643
772	Anomalospiza imberbis	Gambela	3	0	0						
774	Bubalornis niger	Abiata	5	0	0						
775	Dinemellia dinemelli	Abiata	1	0	0						
776	Plocepasser mahali	Abiata	45	0	0						
		Koka	8	0	0						
		Bulcha	19	0	0						
783	Passer griseus	Gambela	1	0	0						
784	Passer swainsonii	Abiata	23	0	0						
		Koka	37	1	2.7	1+1	0	0	1		8872
		Bahadu	26	1	3.8	1+2	4	0	0		9349
		Aseita	23	3	13.0	1+2	1	0	0		17113
						1+2	4	3	4		17795
						1+2	4	4	4		17797

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z		Log. No.
						Serological results					
		Gambela	4	1	25.0	1+1	0	0	1		5616
		Didessa	10	0	0						
		Bulcha	27	1	3.2	1+2	3	0	0		17688
786	Passer luteus	Aseita	4	1	25.0	1+3	3	2	0		17948
787	Passer eminibey	Koka	10	0	0						
		Bahadu	46	3	6.5	1+3	3	2	1		11177
						1+4	2	4	2		11215
						1+3	1	1	0		15454
789	Petronia pyrgita	Abiata	1	0	0						
		Bulcha	16	0	0						
790	Petronia dentata	Didessa	48	2	4.2	1+1	0	0	4		3741
						1+1	0	1	2		8229
	STURNIDAE										
793	Onychognathus morio	Bulcha	3	0	0						
798	Lamprotornis splendidus	Didessa	1	0	0						
799	Lamprotronis chloropterus	Gambela	6	1	16.7	1+1	0	0	0	D1	2319
						1+1	4	4	4		16505
800	Lamprotornis chalybaeus	Abiata	19	0	0						
		Koka	31	0	0						
		Bahadu	57	4	7.0	ND	4	4	4		7935
						1+1	2	0	0		11165
						1+1	0	1	0		13340
						1+1	0	1	0		13344
		Didessa	5	0	0						
		Bulcha	10	1	10.0	1+1	2	0	3		12017
801	Lamprotornis purpuropterus	Abiata	6	0	0						
		Koka	24	0	0						
		Bahadu	5	0	0						
		Filwoha	5	2	40.0	1+1	4	2	1		13487
						1+1	0	0	4		13476
		Aseita	26	7	26.7	1+1	2	0	0		16064
						1+2	2	0	0		16082
						1+1	4	0	0		16083
						1+1	2	0	0		16084
						1+1	3	0	0		16140
						ND	2	0	0		17248
						1+1	2	0	0		17882
		Gambela	3	0	0						
		Bulcha	3	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
802	Cinnyricinclus leucogaster	Didessa	5	0	0					
		Bulcha	6	0	0					
809	Spero superbus	Abiata	22	0	0					
		Koka	18	1	5.6	1+2	2	3	4	9016
811	Creatophora cinerea	Abiata	33	0	0					
		Koka	19	1	5.3	1+1	0	1	2	8861
		Bahadu	52	11	21.1	1+1	1	0	0	11254
						1+2	2	0	0	11297
						1+1	0	0	2	13307
						1+1	0	2	0	13343
						1+1	0	1	0	13347
						1+1	1	0	0	13350
						1+1	0	1	0	13359
						1+2	3	2	1	13360
						1+1	0	2	0	13374
						1+2	1	0	0	13384
						1+2	4	3	3	13426
814	Buphagus erthrorhynchus	Koka	29	3	10.3	1+1	1	1	0	11374
						1+2	0	1	0	18976
						1+2	4	3	3	11663
		Bahadu	4	0	0					
		Bulcha	3	2	66.6	1+1	2	0	2	16713
						1+1	2	0	2	16714
	ORIOLIDAE									
815	Oriolus oriolus	Bahadu	1	0	0					
817	Oriolus larvatus	Abiata	2	0	0					
		Koka	1	0	0					
		Bulcha	15	1	6.7	1+1	2	2	2	16654
	DICRURIDAE									
819	Dicrurus adsmilis	Abiata	8	0	0					
		Koka	13	0	0					
		Bahadu	1	0	0					
		Gambela	4	0	0					
		Didessa	7	0	0					
		Bulcha	9	0	0					
	CORVIDAE									

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BIRDS

U&B Ref.	Species	Locality	Total Tested	Total +ve	Serological results %+ve	Dil.	WN	Nt	Z	Log. No.
824	*Corvus ruficollis*	Kelam	1	0	0					
825	*Corvus capensis*	Kelam	1	0	0					
826	*Corvus rhipidurus*	Bulcha	1	0	0					

SEROLOGICAL RESULTS FROM ETHIOPIA: AMPHIBIANS

Species	Locality	Total Tested	Total +ve	%+ve	Serological results: Dil.	WN	Nt	Z	Log. No.
BUFONIDAE									
Bufo regularis	Abiata	1	0	0					
	Bahadu	9	0	0					
	Gambela	55	1	1.8	1+1	3	0	0	5828
	Didessa	28	1	3.6	1+2	0	4	2	10116
	Bulcha	9	0	0					
RHACOPHORIDAE									
Kassina senegalensis	Gambela	1	0	0					
	Didessa	1	0	0					
RANIDAE									
Dicroglossus occipitalis	Gambela	1	0	0					
Hylarana galamensis	Gambela	7	0	0					
Ptychadena anchietae	Bahadu	2	0	0					
	Gambela	6	1	16.7	1+2	0	1	0	10470
	Bulcha	6	0	0					
Ptychadena huguettae	Gambela	3	0	0					
Ptychadena taenioscelis	Gambela	15	0	0					
Ptychadena sp.	Gambela	1	0	0					
Phrynobatrachus natalensis	Bulcha	1	0	0					
Unidentified Frogs	Gambela	1	0	0					
SEROLOGICAL RESULTS FROM ETHIOPIA: REPTILES									
TESTUDINIDAE									
Kinixys belliana	Gambela	2	0	0					
	Bulcha	5	1	20.0	1+5	2	3	4	12972
CROCODYLIDAE									
Crocodylus niloticus	Gambela	2	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: REPTILES

Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z	Log. No.
AGAMIDAE									
Agama agama	Gambela	164	32	19.5	1+1	0	1	0	2098
					1+2	0	4	0	5861
					1+4	0	2	0	5862
					1+2	0	4	0	5867
					1+1	0	4	0	5872
					1+2	0	4	0	5873
					1+2	0	4	0	5875
					1+1	0	2	0	5877
					1+4	0	2	0	5879
					1+3	0	2	0	5889
					1+2	0	4	0	5891
					1+2	0	4	0	5892
					1+1	0	2	0	5893
					1+3	0	4	0	5894
					1+2	0	4	0	5896
					1+3	0	4	0	5897
					1+1	0	4	0	5898
					1+2	0	4	0	5899
					1+2	0	4	0	5901
					1+1	0	4	0	5902
					1+1	0	4	0	5903
					1+1	0	2	0	5905
					1+2	0	2	0	9168
					1+2	0	2	0	9172
					1+2	0	3	1	9189
					1+2	2	2	4	9222
					1+4	0	4	2	10245
					1+2	0	3	0	10257
					1+2	0	3	0	10274
					1+2	0	3	0	10297
					1+2	0	2	0	10305
					1+5	3	2	0	10306
Agama doriae	Didessa	36	6	16.7	1+4	0	3	0	8418
					ND	0	4	0	9888
					ND	2	1	1	10079
					1+3	2	3	2	14138
					1+2	0	2	0	14152
					1+2	0	2	0	14187
CHAMELIONIDAE									
Chamaeleo senegalensis	Gambela	5	0	0					
	Didessa	17	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: REPTILES

Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results				
Unidentified chamaeleon	Bahadu	1	0	0					
SCINCIDAE									
Mabuya quinquetaeniata	Gambela	3	0	0					
	Didessa	2	0	0					
Mabuya striata	Gambela	1	0	0					
Unidentified Skink	Didessa	1	0	0					
VARANIDAE									
Varanus sp.	Bahadu	1	1	100	1+3	0	2	1	11213
	Gambela	3	0	0					
	Bulcha	1	0	0					
Unidentified Lizards	Gambela	1	0	0					
	Didessa	7	0	0					
COLUBRIDAE									
Philothamnus irregularis	Didessa	1	0	0					
Grayia tholloni	Gambela	1	1	100	1+1	3	0	2	13148
Psammophis sibilans	Didessa	1	0	0					
Psammophis (*sibilans?*)	Gambela	1	0	0					
VIPERIDAE									
Atractaspis microlepidota	Gambela	1	0	0					
Atractaspis irregularis	Didessa	1	0	0					
Unidentified Snakes	Didessa	1	0	0					

SEROLOGICAL RESULTS FROM ETHIOPIA: MAMMALS

excluding bats

Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results				
SORICIDAE									
Crocidura sp.A	Koka	2	2	100	1+2	4	4	4	12477
					1+5	4	4	4	12480
	Didessa	1	1	100	1+1	0	4	4	11857
Crocidura sp.B	Didessa	1	1	100	1+3	3	3	3	11933
Crocidura sp.	Koka	1	1	100	1+1	4	4	3	14089
Unidentified Shrew sp.	Koka	2	2	100	1+1	4	4	4	9112
					1+4	4	4	2	18003
CERCOPITHECIDAE									
Papio anubis	Awash Nat. Park	172	44	25.8	ND	3	0	2	14364
					ND	4	3	4	14366
					ND	4	0	1	14367
					ND	4	1	2	14369
					ND	2	0	0	14371
					ND	4	0	1	14374
					ND	3	1	3	14375
					ND	3	0	0	14385
					ND	4	1	3	14386
					ND	2	0	0	14393
					ND	3	0	0	14394
					ND	4	0	2	14395
					ND	4	0	2	14404
					ND	0	0	2	14410
					ND	4	0	2	14412
					ND	1	0	1	14417
					ND	3	0	2	14418
					ND	4	2	3	14423
					ND	3	0	0	14428
					ND	4	0	1	14432
					ND	4	2	4	14433
					ND	4	1	2	14437
					ND	4	0	1	14438
					ND	2	0	2	14442
					ND	4	4	4	14444
					ND	3	0	0	14445
					ND	2	0	0	14446
					ND	4	0	2	14447
					ND	3	1	4	14448
					ND	2	0	0	14452

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: MAMMALS

excluding bats

Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z		Log. No.
					ND	4	1	2		14457
					ND	4	0	1		14458
					ND	3	0	1		14461
					ND	4	0	1		14463
					ND	1	0	0		14471
					ND	0	0	2		15782
					ND	0	0	2		15783
					ND	0	0	3		15784
					ND	2	2	2		15787
					ND	3	0	2		15791
					ND	3	0	0		15792
					ND	4	0	2		15803
					ND	3	0	2		15806
					ND	4	2	2		15811
	Didessa	6	5	83.3	ND	2	2	0		2945
					ND	2	0	4		3680
					ND	0	0	2		3697
					ND	1	2	2		3790
					ND	0	0	4		11866(a & b
	Bulcha	9	9	100	ND	4	4	4	YF4 D3	1944
					ND	1	3	4		7315
					ND	1	1	3		7350
					ND	2	4	4		7559
					1+1	1	2	4		7560
					1+1	0	0	4		9768
					1+1	2	3	4		12080 a
					ND	4	4	4		12080 b
					ND	0	0	2		16509
					ND	0	0	4		17653
<u>Papio</u> <u>hamadryas</u>	Awash Nat. Park	70	0	0						
<u>Papio</u> <u>anubis</u> <u>x</u> <u>hamadryas</u>	Awash Nat. Park	9	1	11.1	ND	0	0	1		15771
<u>Cercopithecus</u> <u>aethiops</u>	Bahadu	1	0	0						
	Aseita	3	2	66.7	ND	4	2	4		17126 a
					1+2	4	2	3		17126 b
					ND	3	0	2		17339 a
					ND	3	0	1		17339 b
	Didessa	9	8	88.9	ND	0	2	3	YF1 D3	2906
					ND	2	1	4		2946
					ND	0	0	4		2947
					ND	0	0	4		3735
					ND	0	0	4		3736
					ND	0	0	4		3743
					ND	0	0	4		3744

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: MAMMALS

excluding bats

					Serological results						
Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z			Log. No.
					ND	0	0	3			3745
	Bulcha	52	43	82.7	ND	0	2	3			1521
					ND	3	4	4	YF4	D2	1522
					ND	1	0	2			1523
					ND	0	0	2			1524
					ND	1	0	2			1525
					ND	1	2	0			1526
					ND	1	1	2			1527
					ND	4	4	4	YF4	D2	1528
					ND	0	0	2			1529
					ND	2	2	4		D1	1571
					ND	2	2	4	YF3	D2	1572
					ND	2	2	4	YF2	D2	1573
					ND	2	3	4	YF3	D2	1574
					ND	2	3	4	YF3	D2	1575
					ND	2	4	4	YF4	D2	1576
					ND	2	3	4	YF3		1577
					ND	3	4	4	YF3	D3	1598
					ND	3	3	4	YF4	D2	1599
					ND	4	4	4	YF3	D3	1600
					ND	2	3	4	YF3	D2	1601
					ND	2	3	4	YF4	D2	1602
					ND	3	3	4	YF4	D2	1603
					ND	3	4	4	YF3	D3	1604
					ND	4	4	4	YF3	D3	1605
					ND	4	4	4	YF4 SF3	D3	1710
					ND	3	4	4	YF1	D1	1711
					ND	3	2	4			1720
					ND	0	0	3			1744
					ND	3	1	4	YF4	D2	1766
					ND	0	2	4			1767
					ND	1	2	4			1768
					ND	4	3	4			1780
					ND	4	0	4	YF4	D4	1862
					ND	4	4	4	YF4	D3	1945
					ND	0	2	4			7456
					1+1	0	2	4			7482
					ND	0	2	4			7490
					ND	0	0	3			7513
					ND	0	0	4			7556
					ND	0	0	3			7562
					1+1	4	4	2			9599
					ND	2	1	3			13612
					ND	2	2	2			13672

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: MAMMALS

excluding bats

Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results				
SCIURIDAE									
Xerus erythropus	Gambela	2	2	100	1+1	4	2	1	13043
					ND	4	4	4	13177
MURIDAE									
Tatera robusta	Kelam	2	0	0					
Tatera sp.	Koka	25	0	0					
	Aseita	1	0	0					
	Bulcha	1	0	0					
	Kelam	9	2	22.2	ND	2	0	0	18611
					ND	4	4	4	18624
Thamnomys macmillani	Koka	1	0	0					
Oenomys hyoxanthus	Koka	1	0	0					
	Gambela	3	0	0					
	Didessa	1	0	0					
Arvicanthis niloticus	Koka	48	2	4.2	1+1	0	0	1	8877
					1+1	0	0	2	8878
	Bahadu	4	2	50.0	1+1	2	3	3	18482
					1+1	2	2	3	18498
	Aseita	13	3	23.1	1+2	1	0	0	16179
					ND	2	0	0	17284
					ND	1	0	1	17307
	Gambela	38	3	7.9	1+1	0	0	2	5725
					1+1	0	0	2	5726
					1+2	3	3	3	10159
	Didessa	2	0	0					
	Bulcha	1	0	0					
	Kelam	31	19	61.3	ND	2	0	0	18529
					ND	2	2	1	18531
					ND	1	0	0	18532
					ND	1	0	0	18533
					ND	2	0	0	18535
					ND	4	3	4	18539
					ND	1	1	0	18545
					ND	1	0	0	18547
					ND	1	0	0	18548
					ND	2	0	0	18550
					ND	1	0	1	18552
					ND	1	0	0	18554

Cont.

SERULOGICAL RESULTS FROM ETHIOPIA: MAMMALS

excluding bats

Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
						Serological results			
					ND	1	0	0	18555
					ND	1	0	0	18556
					ND	1	0	0	18564
					ND	1	0	0	18586
					ND	2	0	2	18594
					ND	1	0	0	18595
					ND	3	2	1	18626
Lemniscomys striatus	Gambela	6	0	0					
	Didessa	5	0	0					
Rattus rattus	Didessa	48	0	0					
Mastomys natalensis	Abiata	10	0	0					
	Koka	20	0	0					
	Bahadu	2	1	50.0	1+2	0	1	0	18510
	Gambela	49	6	12.2	1+1	1	2	2	5708
					1+1	2	3	3	5711
					1+1	1	1	2	5719
					1+1	0	2	3	5837
					1+1	2	2	2	10237
					1+2	2	4	0	10352
	Didessa	37	1	2.7	1+2	0	2	0	10108
	Bulcha	3	0	0					
	Kelam	1	1	100	ND	1	0	0	18588
Mus sp.A	Abiata	1	0	0					
	Koka	1	0	0					
	Gambela	7	0	0					
	Didessa	2	0	0					
Acomys dimidiatus	Bulcha	3	0	0					
	Kelam	2	0	0					
Dendromus melanotus	Didessa	1	0	0					
Unidentified Rodents	Bahadu	1	0	0					
	Gambela	42	1	2.4	1+2	0	0	2	5798
	Didessa	9	0	0					
	Bulcha	2	0	0					
CANIDAE									
Canis domesticus	Gambela	2	2	100	ND	1	0	1	13087
					ND	0	0	1	13103

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: MAMMALS

excluding bats

Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
VIVERRIDAE									
Genetta sp.	Gambela	2	2	100					
	Bulcha	1	1	100	1+1	0	0	2	7340
Atilax paludinosus	Gambela	1	0	0					
Ichneumia albicauda	Gambela	1	0	0					
Unidentified Mongoose sp.	Gambela	2	1	50	1+1	3	4	4	10434
FELIDAE									
Felis libyca	Bahadu	1	0	0					
Felis domesticus	Gambela	10	4	40.0	ND	0	0	1	13026
					ND	1	0	0	13036
					1+1	4	4	3	13049
					1+1	4	0	0	13052
SUIDAE									
Potamochoerus porcus	Didessa	1	0	0					
Phacochoerus aethiopicus	Bahadu	1	0	0					
	Gambela	1	0	0					

SEROLOGICAL RESULTS FROM ETHIOPIA: BATS

LKY [1] Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
						Serological results				
	PTEROPODIDAE									
2	*Epomophorus minor*	Abiata	8	0	0					
		Koka	61	4	6.6	1+1	4	4	2	11625
						ND	4	4	4	14632
						ND	4	3	2	14680
						1+1	4	3	2	15956
		Bahadu	89	26	29.9	1+1	2	2	2	7819
						ND	4	2	4	8007
						1+1	0	0	3	9322
						1+2	1	3	3	9340
						1+1	3	4	4	9341
						1+1	3	3	3	9383
						1+1	3	3	4	9384
						1+1	2	2	3	9385
						1+2	2	0	0	9402
						1+1	3	4	2	9483
						1+3	3	3	2	9484
						1+1	2	4	4	11164
						1+1	1	4	4	11201
						1+1	2	4	3	11210
						1+1	0	2	1	11271
						1+3	4	3	4	11286
						1+1	3	2	2	11289
						1+3	0	2	3	11291
						1+1	0	0	1	11303
						1+1	1	0	0	11308
						1+1	1	2	4	11309
						1+2	3	4	3	11311
						1+1	3	4	4	12679
						1+2	0	2	3	12684
						1+1	4	4	4	12685
						1+1	3	4	4	15292
		Aseita	10	2	20.0	1+1	4	2	3	15995
						1+1	2	0	0	16170
4	*Epomophorus labiatus anurus*	Bahadu	2	1	50.0	1+2	2	3	2	11269
		Aseita	8	3	37.5	1+1	1	0	0	17158
						ND	3	0	3	17242
						ND	4	0	2	17243
		Gambela	1	0	0					
		Didessa	1	0	0					
		Bulcha	30	2	6.7	1+1	0	0	2	16569
						ND	0	0	2	17583
2/4	E. *minor/labiatus anurus*	Bahadu	23	6	26.1	1+1	1	0	0	15324
						1+1	2	1	1	15327
						1+2	3	3	0	15341

Cont.

1 Reference number from Largen, Kock and Yalden, 1974, Catalogue of the Mammals of Ethiopia. 1. Chiroptera.

SERiOLOGICAL RESULTS FROM ETHIOPIA: BATS

LKY Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z		Log. No.
						1+3	2	1	1		15384
						1+3	4	2	3		15385
						ND	2	2	4		15405
		Aseita	29	5	17.2	1+1	1	1	2		16212
						ND	4	4	3		17295
						ND	0	0	2		17298
						1+4	2	0	1		17301
						ND	0	0	2		17305
5	Epomophorus gambianus	Gambela	39	13	33.3	1+1	2	1	2		6496
						1+1	1	1	3		6638
						ND	1	0	1		13082
						ND	2	0	0		17526
						ND	1	1	2		18781
						ND	3	2	3		18782
						ND	1	0	0		18795
						ND	3	2	3		18812
						ND	2	2	3		18833
						ND	0	0	1		18834
						ND	2	0	0		18835
						ND	1	0	1		18845
						ND	0	0	2		18848
		Didessa	20	3	15.0	ND	3	0	2		17043
						ND	0	1	1		19085
						ND	2	1	2		19143
		Bulcha	56	6	10.7	1+2	1	2	3		9681
						1+2	1	3	3		12051
						1+1	1	2	2		12103
						ND	1	1	1		13007
						ND	0	0	3		17651
						1+1	2	0	1		17725
6	Micropteropus pusillus	Aseita	1	0	0						
		Gambela	97	12	12.4	1+1	0	4	0		2085
						1+2	2	2	3		2296
						1+2	0	0	3	YF2	2704
						1+1	0	0	2	YF2	2711
						1+2	0	4	4		2742
						1+1	0	4	4		2745
						1+1	0	3	3		2775
						1+3	0	0	1		10226
						1+4	2	2	3		16347
						1+4	0	2	0		16372
						1+2	2	2	2		16447
						1+1	2	0	0		18849
		Didessa	77	2	2.6	ND	2	1	1	YF1 D2	2967
						1+1	2	0	2		8233
		Bulcha	2	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BATS

LKY Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Serological results Dil.	WN	Nt	Z		Log. No.
7	*Eidolon helvum*	Gambela	5	3	60.0	ND	4	4	4		16437
						1+1	4	0	0		16478
						ND	4	0	4		16496 a
						1+1	4	2	4		16496 b
		Didessa	3	2	66.7	ND	3	2	3		16928
						ND	4	3	4		17006
		Bulcha	1	0	0						
8	*Rousettus aegyptiacus*	Koka	3	2	66.7	ND	2	1	2		19225
						ND	2	1	2		19226
		Gambela	1	1	100	ND	3	0	2		17512
		Didessa	26	6	23.1	1+1	4	4	4		3721
						1+1	2	0	2		3722
						1+1	0	0	1		3723
						1+1	0	0	2		3724
						1+1	2	2	2		3730
						ND	2	1	2		16847
		Bulcha	6	1	16.7	1+1	0	1	2		12145
9	*Rousettus angolensis*	Didessa	13	1	7.7	1+2	4	3	3		6284
	EMBALLONURIDAE										
13	*Taphozous perforatus*	Gambela	1	0	0						
14	*Taphozous nudiventris*	Abiata	1	0	0						
15	*Taphozous mauritainus*	Gambela	3	1	33.3	1+3	4	3	4	YF4 D1	2257
	NYCTERIDAE										
17	*Nycteris thebaica*	Didessa	1	0	0						
18	*Nycteris hispida*	Bahadu	2	0	0						
		Filwoha	1	0	0						
18a	*Nycteris parisii*	Aseita	1	0	0						
19	*Nycteris aethiopica*	Didessa	1	0	0						
	MEGADERMATIDAE										
20	*Lavia frons*	Filwoha	1	1	100	1+1	2	0	4		13453
		Gambela	18	1	5.6	1+2	1	0	0		16406
		Kelam	1	0	0						

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BATS

LKY Ref.	Species	Locality	Total Tested	Total +ve	%+ve	Dil.	WN	Nt	Z	Log. No.
					Serological results					
21	Cardioderma cor	Bahadu	7	0	0					
		Aseita	10	1	10.0	1+4	1	0	0	17245
		Bulcha	1	0	0					
		Kelam	1	0	0					
	RHINOLOPHIDAE									
22	Rhinolophus Clivosus	Didessa	31	1	3.2	1+4	0	0	2	8283
23	Rhinolophus Landeri	Koka	1	0	0					
		Gambela	10	0	0					
		Bulcha	3	0	0					
25	Rhinolophus simulator	Abiata	1	0	0					
26	Rhinolophus blasii	Koka	2	0	0					
27	Rhinolophus fumigatus	Gambela	1	0	0					
		Didessa	6	0	0					
	Rhinolophs sp.	Didessa	15	1	6.7	1+4	4	3	3	14120
	HIPPOSIDERIDAE									
29	Hipposideros caffer	Gambela	2	0	0					
30	Hipposideros ruber	Didessa	1	0	0					
		Gambela	1	0	0					
31	Hipposideros commersoni	Koka	1	0	0					
34	Triaenops persicus	Koka	2	0	0					
		Bahadu	3	0	0					
	VESPERTILIONIDAE									
37	Eptesicus samalicus	Abiata	3	0	0					
		Didessa	1	0	0					
		Bulcha	8	0	0					
38	Eptesicus capensis	Abiata	1	0	0					
		Koka	1	0	0					
		Didessa	1	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BATS

LKY Ref.	Species	Locality	Total Tested	Total +ve	Serological results %+ve	Dil.	NW	Nt	Z	Log. No.
39	*Eptesicus guiniensis*	Gambela	3	0	0					
40	*Pipistrellus nanus*	Gambela	1	0	0					
		Didessa	4	0	0					
		Bulcha	3	0	0					
41	*Pipistrellus kuhli*	Bulcha	7	1	14.3	1+3	2	2	2	9606
42	*Pipistrellus rusticus*	Gambela	18	0	0					
		Didessa	1	0	0					
43	*Pipistrellus reuppelli*	Bahadu	2	0	0					
45	*Glauconycteris variegata*	Didessa	1	0	0					
46	*Laephotis wintoni*	Koka	4	1	25.0	1+5	2	0	0	12374
51	*Nycticeius schlieffeni*	Gambela	1	0	0					
52	*Nycticeius hindei*	Didessa	2	0	0					
		Bulcha	2	1	50	ND	0	2	2	1587
53	*Nycticeius hirundo*	Gambela	11	0	0	1+3	0	0	0 D2	2674
		Didessa	1	0	0					
		Bulcha	1	0	0					
54	*Myotis tricolor*	Abiata	1	0	0					
58	*Scotophilus nigrita*	Abiata	17	2	11.8	1+2	2	0	0	10498
						1+2	1	2	2	15129
		Koka	4	0	0					
		Gambela	1	0	0					
		Bahadu	1	0	0					
		Bulcha	6	0	0					
59	*Scotophilus leucogaster*	Gambela	31	1	3.2	1+2	0	2	2	2758
	MOLOSSIDAE									
64	*Tadarida pumila*	Abiata	4	0	0					
		Koka	1	0	0					
		Gambela	7	0	0					
65	*Tadarida nigeriae*	Bulcha	1	0	0					
68	*Tadarida condylura*	Koka	1	0	0					
		Gambela	1	0	0					

Cont.

SEROLOGICAL RESULTS FROM ETHIOPIA: BATS

LKY Ref.	Species	Locality	Total Tested	Total +ve	Serological results %+ve	Dil.	WN	Nt	Z	Log. No.
69	Tadarida nanula	Gambela	1	0	0					
	Tadarida sp.	Koka	3	0	0					
		Bahadu	1	0	0					
	Unidentified Fruit Bats	Bulcha	1	0	0					
	Unidentified Insectivorous Bats	Koka	1	0	0					
		Bahadu	6	1	16.7	1+3	1	0	1	18464
		Filwoha	2	1	50	1+2	4	4	4	13497
		Gambela	10	1	10.0	1+2	3	2	0	10446
		Didessa	2	1	50	1+4	4	3	2	14118
		Bulcha	4	0	0					

APPENDIX II

Table 1. Days spent in the Study Areas, November 1969 to April 1977

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Abiata					16					42	4		62
Koka	2	6	42	40	14	2	7	6	28	35	1	19	202
Shalla					4	3	1						8
Total Rift Valley	2	6	42	40	34	5	8	6	28	77	5	19	272
Bahadu	14	12		25	17	14				21	12	1	116
Filwoha										6			6
Aseita		15	14			1			16	7	14	10	77
Total Awash Valley	14	27	14	25	17	15			16	34	26	11	199
Gambela	6	14		13	12	15	18	26				34	138
Didessa	20	38	12		14	9	22	6					121
Bulcha	18	13	23			23	12			1	58	20	168
Kelam			12										12
TOTAL	60	98	103	78	77	67	60	38	44	112	89	84	910

Table 2. Summary of Serological Tests by Hemagglutination - Inhibition

Family	species examined	individuals examined	positives	percentage
Amphibia - amphibians				
Bufonidae - toads	1	102	2	2
Rhacophoridae - tree toads	1	2	0	0
Ranidae - frogs	6	43	1	2
Reptilia - reptiles				
Testudinidae - tortoises	1	7	1	14
Crocodylidae - crocodiles	1	2	0	0
Agamidae - lizards	2	200	38	19
Chamaelionidae - chamaeleons	1	22	0	0
Scincidae - skinks	1	7	0	0
Varanidae - monitors	1	7	0	0
Colubridae - "harmless snakes"	3	4	1	25
Viperidae - vipers	2	2	0	0
Aves - birds				
Pelecanidae - pelicans	2	28	1	3.6
Phalacrocoracidae - cormorants	1	1	0	0
Anhingidae - darters	1	7	0	0
Ardeidae - egrets, herons	14	86	23	26.7
Scopidae - hammerkop	1	4	3	75
Ciconiidae - storks	2	18	1	5.6
Threskiornithidae - ibises, spoonbills	2	4	0	0
Phoenicopteridae - flamingoes	2	35	1	2.9
Anatidae - ducks, geese	10	73	1	1.4
Accipitridae - kites, vultures, buzzards eagles	17	138	43	31.2
Falconidae - falcons	4	6	3	50
Phasianidae - francolins, quail	4	40	9	22.5
Numididae - guineafowl	1	6	1	16.7
Turnicidae - button quail	1	1	0	0
Rallidae - rails, crakes	2	4	0	0
Jacanidae - jacanas	1	38	1	2.6
Rostratulidae - painted snipe	1	15	2	13.3
Charadriidae - plovers	9	235	4	1.7
Scolopacidae - waders	16	427	11	2.6
Recurvirostridae - stilts, avocets	2	36	0	0
Burhinidae - thickknees	2	32	11	34.4
Glareolidae - pratincoles, coursers	3	32	11	34.4
Laridae - gulls, terns	5	26	0	0
Rynchopidae - skimmers	1	2	0	0
Pteroclididae - sandgrouse	3	38	16	42.1
Columbidae - pigeons, doves	17	1588	332	20.9
Psittacidae - parrots	1	1	0	0
Musophagidae - turacos	1	1	1	100
Cuculidae - cuckoos	8	121	11	9.1
Tytonidae - barn owls	1	6	1	16.7
Strigidae - owls	4	24	13	54.2
Caprimulgidae - nightjars	10	208	15	7.2
Apodidae - swifts	1	1	0	0
Coliidae - mousebirds	2	186	7	3.8

Table 2. Summary of Serological T ests by Hemagglutination - Inhibition - cont.

Aves - Birds	species examined	individuals examined	positives	percentage
Trogonidae - trogons	1	4	0	0
Alcedinidae - kingfishers	8	730	20	2.7
Meropidae - bee-eaters	6	374	32	8.6
Coraciidae - rollers	2	11	2	18.2
Upupidae - hoopoes	1	54	15	27.8
Phoeniculidae - wood hoopoes	2	16	0	0
Bucerotidae - hornbills	5	28	5	17.9
Capitonidae - barbets	8	194	4	2.1
Indicatoridae - honeyguides	4	104	2	1.9
Picidae - woodpeckers	5	103	3	3.0
Alaudidae - larks	2	36	1	2.8
Hirundinidae - swallows	8	259	12	4.6
Motacillidae - wagtails, pipits	6	99	3	3.0
Campephagidae - cuckoo-shrikes	2	71	2	2.8
Pycnonotidae - bulbuls	3	327	6	1.8
Laniidae - shrikes	15	404	68	16.8
Muscicapidae (Turdinae) - thrushes	22	602	170	28.2
Muscicapidae (Timaliinae) - babblers	3	112	7	6.3
Muscicapidae (Sylviinae) - warblers	30	994	33	3.3
Muscicapidae (Muscicapinae) - flycatchers	10	319	17	5.3
Paridae - tits	1	8	0	0
Nectariniidae - sunbirds	10	568	18	3.2
Zosteropidae - white-eyes	2	100	2	2.0
Emberizidae - buntings	2	42	1	2.4
Fringillidae - finches	7	321	5	1.6
Estrildidae - waxbills, firefinches	22	1161	16	1.4
Ploceidae - weavers	35	2145	56	2.6
Sturnidae - starlings oxpeckers	9	395	33	8.4
Oriolidae - orioles	2	19	1	5.3
Dicruridae - drongos	1	42	0	0
Corvidae - crows	3	3	0	0
Mammalia - Mammals				
Pteropodidae - fruit bats	7	612	101	16.5
Emballonuridae - sheath-tailed bats	3	5	1	20.0
Nycteridae - slit-faced bats	4	6	0	0
Megadermatidae - false vampires	2	39	3	7.7
Rhinolophidae - horseshoe bats	5	70	2	2.9
Hipposideridae - leaf-nosed bats	4	10	0	0
Vespertilionidae - mouse-eared and pistrelle bats	15	138	6	4.3
Molossidae - free-tailed bats	4	20	0	0
Soricidae - shrews	3	7	7	100
Cercopithecidae - monkey, baboons (includes 1 hybrid)	3	331	112	33.8
Sciuridae - squirrels	1	2	2	100
Muridae - mice	10	433	41	9.5
Canidae - dogs	1	2	2	100
Viverridae - genets, mongoose	3	7	2	28.3
Felidae - cats	2	11	4	36.4
Suidae - pigs	2	3	0	0

Table 3. Birds Showing Significant Serological Reactions

Family Species	No. examined	No. positive	Percentage
Ardeidae	86	23	26.7
Ixobrychus minutus	13	2	15.4
Ardeola ibis	18	4	22.2
Butorides striatus	19	13	68.4
Accipitridae	77	26	33.8
Milvus migrans	49	13	26.5
Accipiter tachiro	13	5	38.5
Accipiter badius	27	3	11.1
Phasianidae	46	10	21.7
Francolinus sephaena	13	6	46.2
Rostratulidae	15	2	13.3
Rostratula benghalensis	15	2	13.3
Burhinidae	32	11	34.4
Burhinus senegelensis	29	10	34.5
Glareolidae	32	11	34.4
Pluvianus aegyptius	25	10	40.0
Pteroclididae	38	6	15.8
Pterocles quadricinctus	13	3	23.1
Columbidae	1578	332	21.0
Streptopelia lugens	55	8	14.5
Streptopelia semitorquata	162	17	10.5
Streptopelia decipiens	593	139	23.4
Streptopelia vinacea	104	25	24.0
Streptopelia rosegorisea	50	17	34.0
Oena capensis	210	40	19.0
Turtur afer	168	23	13.7
Treron australis	10	1	10.0
Treron waalia	41	11	26.8
Cuculidae	121	11	10.0
Centropus monachus	11	4	36.4
Centropus superciliosus	59	6	10.2

Table 3. Birds Showing Significant Serological Reactions - cont.

Family Species	Total examined	Total positive	Percentage
Strigidae	23	13	56.5
Otus scops	17	10	58.8
Caprimulgidae	208	15	7.2
Caprimulgus inornatus	15	2	13.3
Caprimulgus climacurus	10	1	10.0
Meropidae	374	32	8.6
Merops nubicus	153	16	10.5
Merops albicollis	22	4	18.2
Merops bulocki	13	2	15.4
Upupidae	54	15	27.8
Upupa epops	54	15	27.8
Bucerotidae	28	5	17.9
Tockus deckeni	15	2	13.3
Hirundinidae	259	12	4.6
Hirundo daurica	10	1	10.0
Laniidae	404	68	16.8
Nilaus afer	11	3	27.3
Dryoscopus gambensis	43	25	58.1
Tchagra senegalla	45	10	22.2
Laniarius aethiopicus	57	7	12.3
Laniarius funebris	61	13	21.3
Muscicapidae (Turdinae)	602	170	28.2
Cercomela familiaris	15	3	20.0
Turdus pelios	347	149	42.9
Turdus olivaceus	22	10	45.5
Muscicapidae (Muscicapinae)	319	17	5.3
Batis orientalis	21	3	14.3
Batis minor	18	3	16.7
Nectariniidae	568	18	3.2
Nectarinia senegalensis	52	7	13.5

Table 3. Birds Showing Significant Serological Reactions - cont.

Family Species	Total examined	Total positive	Percentage
Fringillidae	321	5	1.6
Serinus leucopygius	12	2	16.7
Sturnidae			
Lamprotornis purpuropterus	72	9	12.5
Creatophora cinerea	104	12	11.5
Buphagus erythrorhynchus	36	5	13.9

Total 45 species in 22 families

Table 4. Comparison of Significant Serological Results Within Bird Species at Different Study Sites.

Species	Rift Valley exam. pos.%	Gambela exam. pos.%	Awash Valley exam. pos.%	Bulcha exam. pos.%	Didessa exam. pos.%
Milvus migrans		11-4-35.4		14-3-21.4	15-5-33.3
Burhinus senegalensis	15-3-20.0	12-6-50.0			
Streptopelia semitorquata	50-4- 8.0	15-6-40.0		61-3- 4.9	27-4-14.8
Streptopelia decipiens	256-22- 8.6	85-28-32.0	241-81-33.6		
Streptopelia vinacea		80-24-30.0			24-1- 4.2
Oena capensis	56-9-16.1	55-20-36.4	99-11-11.1		
Turtur afer	13-0- 0	31-4-12.9	56-17-30.4	50-1- 2.0	18-1- 5.6
Caprimulgus clarus	31-0- 0		79-11-13.9	36-1- 2.8	
Merops nubicus	58-2- 3.4		67-11-16.4	15-2-13.3	13-1- 7.7
Merops pusillus	24-1- 4.2	19-3-15.8	49-4 - 8.2		40-0- 0
Upupa epops	24-2- 8.3		39-12-30.8		
Tchagra senegala	11-1- 9.1			12-2-16.7	14-2-14.3
Laniarius aethiopicus	28-3-10.7			22-3-13.6	
Turdus pelios	52-12-23.1	139-63-45.3		106-54-50.9	49-20-40.8
Turdoides rubiginosus	35-0- 0		21-4 -19.0	39- 2- 5.1	
Camaroptera brevicaudata	61-1- 1.6	15-0 -0	52-2 - 3.8	37- 5-13.5	36-0 -0
Sylvietta brachyura			34-2 - 5.9		11-3 - 27.3
Nectarinia senegalensis		14-1 - 7.1			29-5 - 17.2
Nectarinia habessinica	13-0- 0		52-6 -11.5		
Pytelia phoenicoptera		29-3 -10.3			48-0 - 0
Lagonosticta rufopicta		44-0 -0			10-1 -10.0
Lamprotornis chalybaeus	50-0- 0		57-4 - 7.0	10-1-10.0	
Lamprotornis purpuropterus	30-0- 0		36-9 -25.0		
Creatophora cinerea	52-1- 1.9		52-11-21.1		
Totals	859-61- 7.1	520-159-30.6	934-185-19.8	387-75-19.4	273-42-15.8

Table 5. Families and species of bats with Significant Antibody Titers

Family, Species	No. examined	No. positive	Percentage
Pteropodidae	612	101	16.5
Epomophorus minor	168	32	19.0
Epomophorus labiatus	42	6	14.3
Epomophorus gambianus	115	22	19.1
Micropteropus pusillus	177	14	7.9
Eidolon helvum	9	5	55.6
Rousettus aegyptiacus	36	10	27.8
Rousettus angolensis	13	1	7.7
Megadermatidae	39	3	7.7
Lavia frons	20	2	10.0

Table 6. Comparison of Significant Serological Results Within Bat Species at Different Study Sites*

Species	Rift Valley	Gambela	Awash Valley	Bulcha	Didessa
Epomophorus minor	69-4-5.8		99-28-28.3		
Epomorphus gambianus		39-13-33.3		56-6-10.7	20-3-15.0
Micropteropus pusillus		97-12-12.4			77-2- 2.6
Totals	69-4-5.8	136-25-18.4	99-28-28.3	56-6-10.7	97-5- 5.2

*Numbers refer to number examined - number positive - percentage positive

Table 7. Families and species of other mammals with Significant Antibody Titers*

Cercopithecidae	112 - 331 - 33.8	
Papio anubis		187 - 58 - 31.0
Cercopithecus aethiops		65 - 53 - 81.5
(Muridae)		
Arvicanthis nilotica		137 - 29 - 21.2
Felidae	4 - 11 - 36.4	
Felis domesticus		10 - 4 - 40.0

*Numbers refer to
number examined -
number positive -
percentage positive

Table 8. Serological results from birds bled more than once.

Locality	Age	Date	Serum No.	Dil.[1]	Results WN[2]	Nt[3]	Z[4]
Melierax metabates							
Bulcha	Ad	20.vi.74	17652	ND	3	2	2
"	Ad	25.xi.74	18314	ND	3	0	2
Burhinus senegalensis							
Gambela	PJ	12.xii.72	14008	1+1	0	0	0
"	Ad	14.v.74	17432	ND	4	3	4
Streptopelia decipiens							
Koka	PJ	31.iii.71	8833	1+1	0	0	0
"	Ad	26.iii.72	12182	1+2	0	0	0
Abiata	PJ	13.x.71	10516	1+1	0	0	0
"	PJ	23.x.71	10817	1+1	0	0	0
Bahadu	PJ	29.i.71	8111	ND	0	0	0
"	Ad	17.x.72	13397	ND	2	0	0
Aseita	Ad	6.xi.73	16104	1+2	0	0	0 }
"	Ad	23.iii.74	17258	1+1	0	0	0 }
"	Ad	4.xi.73	16046	ND	0	0	0 }
"	Ad	27.iii.74	17384	ND	0	0	0 }
"	Ad	12.xi.73	16200	1+2	0	0	0 }
"	Ad	19.iii.74	17219	ND	0	0	0 }
"	Ad	5.xi.73	16074	1+1	0	0	0 }
"	Ad	26.iii.74	17356	ND	0	0	0 }
Ceryle maxima							
Gambela	Ad	14.v.74	17425	1+3	0	0	0
"	Ad	26.iv.75	18807	1+2	0	0	0
Pogoniulus pusillus							
Bulcha	PJ	19.i.74	16535	1+3	0	0	0
"	Ad	17.vi.74	17600	1+2	0	0	0
Dryoscopus gambensis							
Bulcha	?	22.vi.74	17681	1+1	3	0	1 }
"	?	19.xi.74	18245	1+1	2	2	0 }
"	?	18.xi.70	7306	1+2	2	1	1 }
"	Ad	17.xi.74	18220	1+2	4	2	4 }

[1]Dilution, [2]West Nile, [3]Ntaya, [4]Zika.

Table 8. Serological results from birds bled more than once - Cont.

Locality	Age	Date	Serum No.	Dil.[1]	Results WN[2]	Nt[3]	Z[4]
Turdus pelios							
Koka	Ad	8.iii.71	8528	1+2	0	0	0
"	Ad	20.ix.75	19315	ND	0	0	0
Didessa	PJ	25.vi.70	6255	1+2	0	0	0
"	Ad	12.vii.71	10081	1+1	0	0	0
"	Ad	27.vii.70	6281	1+2	0	0	0
"	Ad	15.ii.74	16789	1+1	4	0	0
"	Ad	15.vi.75	19118	1+1	3	0	1
"	Ad	18.ii.74	16873	ND	3	0	1
"	Ad	16.vi.75	19136	1+1	3	1	2
"	Ad	30.i.72	11770	1+2	0	0	0
"	Ad	16.vi.75	19133	ND	0	0	0
Bulcha	Ad	19.iii.73	14793	1+1	4	2	2
"	Ad	21.vi.74	17665	1+1	1	4	3
"	PJ	17.xii.69	1939	ND	0	1	2
"	Ad	10.xi.72	13604	1+1	0	0	0
"	Ad	25.i.74	16669	1+1	4	2	4
"	Ad	17.vi.74	17601	1+2	2	0	2
"	Ad	29.xi.74	18364	1+2	2	0	2
"	Ad	24.xi.70	7424	1+1	0	0	0
"	Ad	20.xi.72	13721	ND	0	0	0
"	Ad	15.xii.69	1876	ND	1	1	0
"	Ad	21.xi.70	7365	1+1	0	0	0
"	Ad	21.i.74	16589	1+2	2	1	1
"	Ad	21.xi.70	7363	1+1	2	2	2
"	Ad	3.vii.72	12788	1+2	2	3	0
"	Ad	25.iii.73	14955	1+1	0	0	0
"	Ad	28.i.74	16747	ND	4	3	3
"	Ad	9.vii.72	12982	1+1	2	2	3
"	Ad	18.iii.73	14779	1+2	0	0	0
"	Ad	13.vi.71	9738	1+1	0	0	0
"	Ad	12.xi.72	13620	1+1	4	3	1

Table 9. Seasonal incidence of antibody prevalence in _Turdus_ _pelios_.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bulcha:	Examined	13	1	20	-	-	13	4	-	-	0	42	15	108
	Positive	10	0	12	-	-	4	3	-	-	-	19	6	54
	%	8	0	60	-	-	31	75	-	-	-	45	40	50
Gambela:	Examined	25	6	-	7	2	1	23	14	-	-	-	62	140
	Positive	7	3	-	5	1	0	16	8	-	-	-	23	63
	%	28	50	-	71	50	0	70	57	-	-	-	37	45
Didessa:	Examined	6	18	7	-	4	6	8	0	-	-	-	-	49
	Positive	1	10	3	-	1	3	2	-	-	-	-	-	20
	%	17	56	43	-	25	50	25	-	-	-	-	-	41
Rift Valley:	Examined	0	0	6	3	14	0	0	0	15	11	0	1	50
	Positive	-	-	0	0	3	-	-	-	3	4	-	1	11
	%	-	-	0	0	21	-	-	-	20	36	-	100	22
Total:	Examined	44	25	33	10	20	20	35	14	15	11	42	78	347
	Positive	18	13	15	5	5	7	21	8	3	4	19	30	148
	%	41	52	45	50	25	35	60	57	20	36	45	38	43

Note: Included in this table are 2 sera from Bulcha and 1 from Gambela which were not tested, but it is not known from which months they should be deducted. In the Rift Valley 2 further birds were tested, of which 1 was positive, but it is not known into which month(s) these should be placed.

Table 10. Neutralization Test Results of HAI Positive Bird Sera in Adult Mice Receiving 50-100 LD_{50} of Virus.*

		Number of Sera Protecting Any Mice					
Locality	No. Tested	Banzi	Wesselsbron	Spondweni	Uganda S	Zika	West Nile
Bahadu	16	2			1		1
Gambela	7				1		1
Bulcha	1						1
Koka	7				2		3
Didessa	2						2

*Where more than one virus was neutralized only that virus showing greatest neutralization was tabulated.

Table 11. Neutralization Test Results of HAI Positive Bird Sera in Suckling Mice Receiving 25 LD_{50} of Virus.*

Locality	No. Tested	Number of Sera Protecting at least 50% of Mice					
		Banzi	Wesselsbron	Spondweni	Zika	West Nile	Ntaya
Aseita	82	1	0	1	0	17	4
Bahadu	36	1	0	0	0	7	1
Gambela	51	1	1	0	2	15	3
Bulcha	57	1	0	0	0	13	1
Didessa	23	0	0	0	0	5	1
Koka	22	0	0	0	0	5	1
Abiata	5	0	0	0	0	3	0
Total	276	4	1	1	2	65	11

*Where more than one virus was neutralized only that virus showing greatest neutralization was tabulated.

Table 12. Cross Reaction Pattern by Neutralization Test among Ethiopian Bird Sera Neutralizing more than One Group B Virus.

Locality	No. Tested	Banzi	Wesselsbron	Spondweni	Zika	West Nile	Ntaya
Aseita	11	4/8		4/4			5/8
		8/8	3/8				
						1/8	8/8
					1/8		7/8
			4/8			5/8	6/8
						8/8	1/8
						6/8	1/8
						8/8	2/8
						6/8	3/8
						7/8	6/8
						5/8	5/7
Bahadu	8				1/5		5/7
						8/8	6/8
						6/8	3/8
						7/8	5/8
						5/8	2/8
						7/8	2/8
		5/8			1/8	8/8	4/8
					5/8	5/8	5/8
Gambela	12		5/8				1/8
					7/7	4/8	4/8
					7/8	5/8	1/8
					3/8		5/8
						6/8	1/8
						8/8	7/8
						4/8	1/8
						7/8	5/8
						6/8	3/8
						5/8	1/8
					2/8	7/8	3/8
					1/8	8/8	6/7
Bulcha	9	6/8				2/8	
						4/8	1/8
						6/8	2/8
						6/8	2/8
						7/8	4/8
						4/8	1/8
						8/8	1/8
					1/8	8/8	6/8
					4/8	8/8	5/8

Table 12. Cross Reaction Pattern by Neutralization Test among Ethiopia Bord Sera Neutralizing more than One Group B Virus - cont.

Locality	No. Tested	Banzi	Wesselsbron	Spondweni	Zika	West Nile	Ntaya
Didessa	3					4/8	6/8
						7/8	2/8
						5/8	1/8
Koka	3					6/8	1/8
						5/8	2/8
						5/8	1/8
Aseita	2					7/8	1/8
						7/8	2/8

Table 13. Human Sera HAI Test Results

Locality Age	Number Tested	1/Serum Titer	Yellow Fever No.	Yellow Fever %	West Nile No.	West Nile %	Zika No.	Zika %	Dengue No.	Dengue %	Group B Multiply Reactive No.	Group B Multiply Reactive %	Chikungunya No.	Chikungunya %
Didessa		10	0		18		15		7				2	
		20	2		0		1		2				0	
Adults	210	40	3		0		0		0				0	
		≥ 80	2		0		1		0				6	
		Total	7	3.3%	18	8.6%	17	8.1%	9	4.3%	69	32.9%	8	3.8%
under 12 years	125	10	2		9		4						1	
		20	0		0		0						0	
		40	0		0		0						0	
		≥ 80	0		0		0						1	
		Total	2	1.6%	9	7.2%	4	3.2%	0		7	5.6%	2	1.6%
Koka		10	1		5		5		3				1	
		20	1		0		0		0				0	
Adults	132	40	0		0		1		0				0	
		≥ 80	1		0		0		0				0	
		Total	3	2.3%	5	3.8%	6	4.5%	3	2.3%	28	21.2%	1	0.8%
under 12 years	78	10	1		3		3		6					
		20	0		0		0		1					
		40	0		0		0		0					
		≥ 80	0		0		0		0					
		Total	1	1.3%	3	3.8%	3	3.8%	7	9.0%	7	9.0%	0	

Table 13. Human Sera HAI Test Results - cont.

Locality Age	Number Tested	1/Serum Titer	Yellow Fever No.	Yellow Fever %	West Nile No.	West Nile %	Zika No.	Zika %	Dengue No.	Dengue %	Group B Multiply Reactive No.	Group B Multiply Reactive %	Chikungunya No.	Chikungunya %
Bulcha		10			0								1	
		20			6								1	
Adults	46	40			2								0	
		≥ 80	1		1								1	
		Total	1	2.2%	9	19.6%	0		0		34	73.9%	3	6.5%
under 12 years	7	10			1									
		20			0									
		40			0									
		≥ 80			0									
		Total	0		1	14.6%	0		0		2	28.6%	0	
Bahadu		10												
		20												
Adults	39	40												
		≥ 80												
		Total	0		0		0		0		39	100%	0	
under 12 years		10			0									
		20			0									
		40			1									
		≥ 80			1									
		Total	0		2	16.7%	0		0		10	83.3%	0	

Table 14. Positive HAI Human Sera CF Test Results

Locality Age	Number Tested	Yellow Fever		West Nile		Zika		Group B Multiply Reactive		Chikungunya		Anticomplimentary	
Didessa													
Adults	117	21	17.9%	3	2.6%	4	3.4%	28	23.9%	30	25.6%	33	28.2%
under 12 years	30	3	10.0%	0		2	6.6%	12	40.0%	18	60.0%	2	6.6%
Koka													
Adults	132	3	4.4%	5	7.4%	2	2.9%	6	8.8%	7	10.3%	6	8.8%
under 12 years	18	0		2	11.1%	0		4	22.2%	6	33.3%	2	11.1%
Bulcha													
Adults	38	1	2.6%	1	2.6%	0		10	26.3%	12	31.6%	14	36.8%
under 12 years	3	0		0		0		1	33.3%	1	33.3%	1	33.3%
Bahadu													
Adults	39	0		4	10.3%	0		1	2.6%	4	10.3%	6	15.4%
under 12 years	12	0		1	8.3%	1	8.3%	2	16.6%	1	8.3%	3	25.0%

Table 15. Neutralization Test Results of HAI Positive Human Sera in Suckling Mice Receiving 100 LD_{50} of Virus.

Locality Age	Number Tested	Antibody*	Yellow Fever No.	Yellow Fever %	West Nile No.	West Nile %	Zika No.	Zika %	Dengue I No.	Dengue I %	Group B Multiply Reactive No.	Group B Multiply Reactive %	Japanese B Encephalitus No.	Japanese B Encephalitus %
Didessa														
Adults	117	NT	22	18.8%	2	1.7%	5	4.2%	Not Tested		0		Not Tested	
		NT + CF	24	20.5%	1	0.9%	2	1.7%			3	2.6%		
		Total	46	39.3%	3	2.6%	7	5.9%			3	2.6%		
under 12 years	30	NT	0		0		0		Not Tested		0		Not Tested	
		NT + CF	1	3.3%	0		0				0			
		Total	1	3.3%	0		0				0			
Koka														
Adults	68	NT	6	8.8%	1	1.5%	Not Tested		0		0		Not Tested	
		NT + CF	3	4.4%	2	2.9%			0		1	1.5%		
		Total	9	13.2%	3	4.4%			0		1	1.5%		
under 12 years	18	NT	0		1	5.6%	Not Tested		0		0		Not Tested	
		NT + CF	0		1	5.6%			0		0			
		Total	0		2	11.2%			0		0			
Bulcha														
Adults	38	NT	3	7.9%	0		0		0		0		Not Tested	
		NT + CF	0		0		0		0		0			
		Total	3	7.9%	0		0		0		0			

Table 15. Neutralization Test Results of HAI Positive Human Sera in Suckling Mice Receiving 100 LD_{50} of Virus. - cont.

Locality Age	Number Tested	Antibody*	Yellow Fever No.	Yellow Fever %	West Nile No.	West Nile %	Zika No.	Zika %	Dengue I No.	Dengue I %	Group B Multiply Reactive No.	Group B Multiply Reactive %	Japanese B Encephalitus No.	Japanese B Encephalitus %
Bahadu														
		NT			0		0		0		0		3	7.9%
Adults	39	NT + CF	Not Tested		6	15.8%	0		0		8	20.5%	0	
		Total			6	15.8%	0		0		8	20.5%	3	7.9%
		NT	Not Tested		0		0		0		0		1	8.3%
under 12 years		NT + CF	Not Tested		0		0		0		1	8.3	0	
		Total			0		0		0		1	8.3%	1	8.3%

*NT = Neutralizing antibody alone, NT + CF = Neutralizing antibody plus CF antibody.

Table 16. Virus Isolates from Wild Vertebrates and Sentinel Mice in Ethiopia.

Species	Age	Locality	Date	Tissue	Virus	Ref. No.
Ardeola ralloides	Ad	Koka	22.ix.75	Whole blood	Dugbe	4732/19216
Milvus migrans	1Y	"	10.ix.76	" "	West Nile	4812/19622
Melierax metabates		"	23.ix.75	" "	Dugbe	4739/19362
Francolinus clappertoni	Ad	"	10.ix.76	" "	West Nile	4813/19623
Streptopelia decipiens		Aseita	12.xii.75	" "	Dugbe	4534/19473
Streptopelia roseogrisea	1Y	Dubte	9.ix.74	Serum	Abu Mina	626/17555
Dryoscopus gambensis		Bulcha	22.ix.74	Whole blood	Dugbe	3785/18291
" "		"		Serum	West Nile	1334/18395
" "		Koka	22.ix.75	Whole blood	Dugbe	4736/19347
" "		Bulcha	6.ii.76	" "	Dugbe	4458/19530
" "		Koka	29.viii.76	" "	missing	4764/19593
Tchagra senegala		"	24.ix.75	" "	Dugbe	4740/19367
" "		"	"	" "	"	4741/19378
Laniarius aethiopicus		"	23.ix.75	" "	"	4737/19349
" "		"		Pooled tissue	West Nile	4767/19595
" "		"	"	Whole blood	" "	4768/19595
" "		"		Pooled tissue	West Nile	4811/19621
Laniarius funebris		Bulcha	6.ii.76	Serum/Whole blood	Bunya§	3530/19533
" "		Koka	31.viii.76	Whole blood	West Nile	4771/19597
" "		"	"	Pooled tissue	West Nile	4772/19597
Turdus pelios		Bulcha		Kidney	West Nile	4152/18394
" "	Ad	Koka	30.iv.75	Serum	West Nile	3307/19045
" "		"		Whole blood	Dugbe	4731/19215
" "		"		Liver	West Nile	3662/19330
" "		"		Whole blood	West Nile	4733/19330
" "		"	22.ix.75		Dugbe	4734/19335
" "		"	"	Pooled tissue	"	4735/19346
" "		"	23.ix.75	Serum	Dugbe	4738/19360
" "	Ad	"	31.viii.76	Whole blood	West Nile	4769/19596
" "		"	"	Pooled tissue	missing	4770/19596
" "	Juv.	"	"	Whole blood	West Nile	4773/19598
" "	"	"	"	Pooled tissue	missing	4774/19598
" "	1Y	"	9.ix.76	Whole blood	West Nile	4808/19620
" "	1Y	"	"	Whole blood	*	4809/19620
§Unidentified, probably		"	26viii-12ix76	Pooled tissue	West Nile +	4810/19621
Turdus pelios		"	"	Whole blood	" "	4811/19621
" "		"	"	Whole blood	" "	4812/19622
" "		"	"	Pooled tissue	" "	4813/19623
" "		"	"	Whole blood	" "	4814/19623
Bubalornis niger		"		Whole blood	West Nile	4766/19594
Arvicanthis niloticus		Aseita	27.30.ix.74	Kidney	In progress	792/55640
" "		"	30.ix.74	Serum	Arumowot	798/55646
" "		"	"	"	Arumowot	808/55651
Arvicanthis niloticus		Kelam	12.iii.75	"	In progress	3024/59995
Mastomys natalgnsis		Gambela	27.iv.75	Whole blood	Dugbe	4255/62060

§Identified by electron microscopy.
*Does not react with Group A, Group B, or Dugbe (Congo group) by CF.
+Identified by CF.

Table 17. Seasonal population fluctuations of <u>Turdus pelios</u>

Month	Rift Valley	Gambela	Didessa	Bulcha	Totals
Jan	4/0/0*	7/210/30/0	20/13/0.7	19/55/2.9	50/278/5.6
Feb	7/0/0	15/450/30.0	39/9/0/2	13/27/2.1	74/486/6.6
Mar	29/12/0.4			23/84/3.7	52/96/1.8
Apr	32/22/0.7	13/33/2.5			45/55/1.2
May		20/64/3.2			20/64/3.2
June		17/85/5.0	24/40/1.7	25/29/1.2	66/154/2.3
Jul		24/103/4.3	22/10/0.5	12/4/0.3	58/117/2.0
Aug	6/14/2.3	27/111/4.1	6/1/0.2		39/126/3.2
Sep	29/14/0.5				29/14/0.5
Oct	82/57/0.7				82/57/0.7
Nov	5/6/1.2			50/66/1.3	55/72/1.3
Dec	20/3/0.2	37/383/10.4		14/25/1.8	71/411/5.8

*Numbers refer to days in field/total birds seen/birds per day.

Table 18. Seasonal Weight Changes in Streptopelia decipiens

Month	Rift Valley N	Rift Valley $\overline{wt}$	Awash Valley N	Awash Valley $\overline{wt}$	Gambela N	Gambela $\overline{wt}$	Kelam N	Kelam $\overline{wt}$	Total N	Total $\overline{wt}$
Jan			47	144.8					47	144.8
Feb										
Mar	42	152.1					1	138.5	43	151.8
Apr	21	150.6	6	137.2	37	131.1			64	138.1
May			8	144.0	1	154.0			9	145.1
Jun			1	162.6					1	162.6
Jul	10	160.4			2	157.0			12	159.8
Aug										
Sep	112									
Oct	112	166.9	2	150.3					114	166.6
Nov	4	179.6	30	142.9					34	147.3
Dec	34	161.5			17	132.8			51	151.9
Total	223	161.7	94	144.0	57	132.9	1	138.5	375	152.8

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Ash, J.S. A Migration of Palearctic Birds Inland in Ethiopia.

________ New Birds from Djibouti.

________ The Birds of Ethiopia. (Book)

________ The Migrant Bird Community of an Ethiopian Woodland in Midwinter.

________ Kingfisher Migration in Ethiopia.

________ Further Evidence for "Ortstreue" from Ethiopia.

________ The distribution of Three Little Known birds in Ethiopia: *Hirundo megaensis*, *Zavatariornis stresemanni* and *Spreo albicollis*.

________ Ornithological Observations from Yemen.

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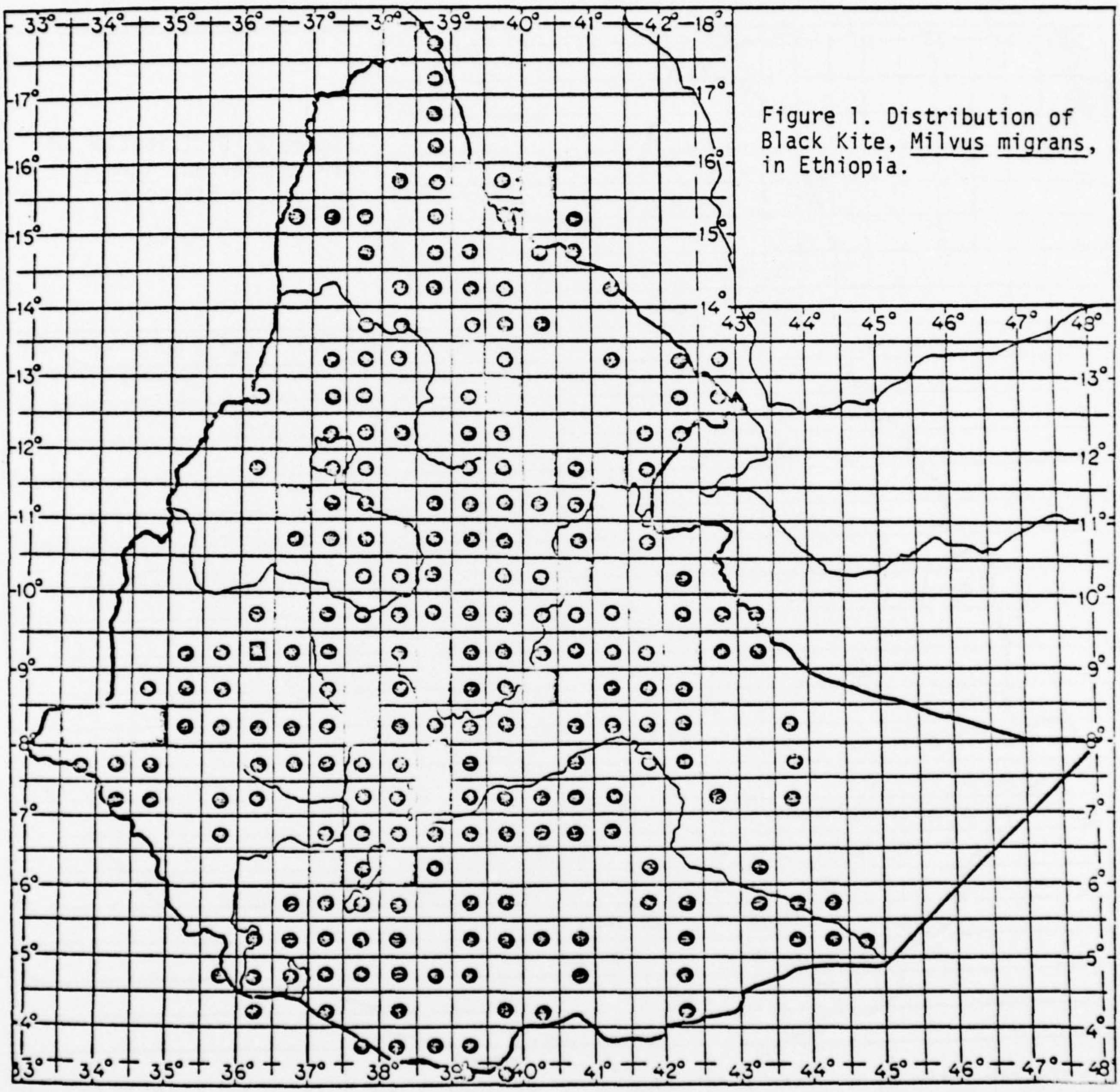

Figure 1. Distribution of Black Kite, Milvus migrans, in Ethiopia.

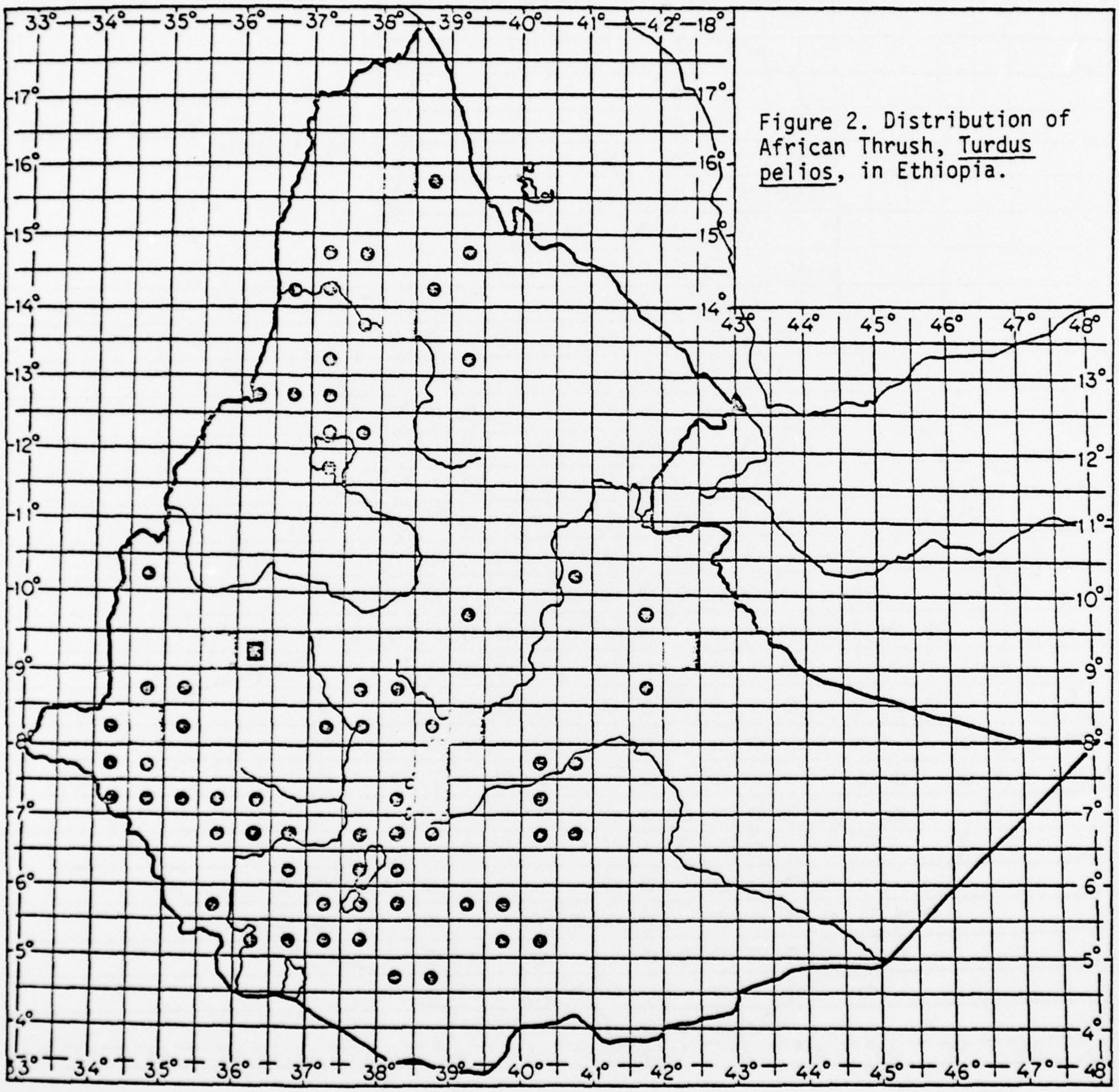

Figure 2. Distribution of African Thrush, Turdus pelios, in Ethiopia.

Figure 3. Foreign localities where birds banded in Ethiopia (dotted area in Africa) were subsequently recovered or where birds recovered in Ethiopia were previously banded. A Pelecanus onocrotalus (2), B Ardea cinerea, C Ardeola ralloides, D (=hatched area in Europe) Ciconia ciconia, (51), E Ciconia nigra (2), F Phoenicopterus ruber(2), G Phoenicopterus minor, H Milvus migrans (2), J Buteo buteo, K Calidris ferruginea, L Calidris minuta, M Philomachus pugnax, N Tringa terek, O Pluvianus aegyptius, P Larus fuscus (5), Q Sterna caspia, R Ceryle rudis, S Halcyon leucocephala (2), T Upupa epops, U Luscinia megarhynchos, V Sylvia atricapilla (3), W Acrocephalus griseldis, X Acrocephalus scirpaceus, Y Hirundo *rustica* (4), Z Riparia riparia, a Lanius nubicus, b Oriolus oriolus, c Sturnus vulgaris, d Streptopelia turtur (2), e Motacilla flava.

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