

The isolation of arboviruses including a new flavivirus and a new bunyavirus from *Ixodes (Ceraticoides) uriae* (Ixodoidea: Ixodidae) collected at Macquarie Island, Australia, 1975-1979.

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by

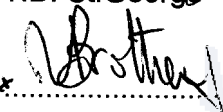
St. George, T.D., Doherty, R.L., Carley, J.G., Filippich, C. Brescia, A., Casals, J
Kemp, D.H. and Brothers, N.

I initiated the project to isolate more viruses from Antarctic bird ticks. Nigel Brothers collected the ticks and supplied supporting data. Dr D.J. Griffiths, Dr M.M. Bryden, Dr G.W. Johnstone and Dr Ian Morgan also collected and transported ticks. The ticks were prepared for inoculation into mice by Neville Hunt and Steven Davis. I substituted the inoculation of tissue cultures for virus isolation for the traditional mouse brain isolation as a much more economical technique. Dr D.H. Kemp identified the ticks. The initial identification procedures were carried out at the Queensland Institute of Medical Research.

The "new" virus identifications were carried out at the Yale Arbovirus Research Unit.


T.D. St. George

Date 14.2.2000


Nigel Brothers

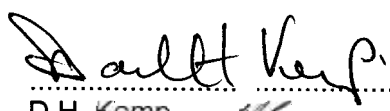
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Ticks and arboviruses in Australia and its territories

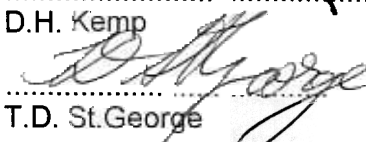
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St. George, T.D. and Kemp, D.H.

I contributed the expertise on ticks and their biology and Table 1. The balance of the research came from Dr St. George's group who were responsible for the rest.


D.H. Kemp

Date 14.2.2000


T.D. St. George

Date 14.2.2000

THE UNIVERSITY OF SYDNEY



THE POST-GRADUATE COMMITTEE IN VETERINARY SCIENCE

REFRESHER COURSE FOR VETERINARIANS

PROCEEDINGS No. 60

REFRESHER COURSE ON
ADVANCES IN VETERINARY VIROLOGY

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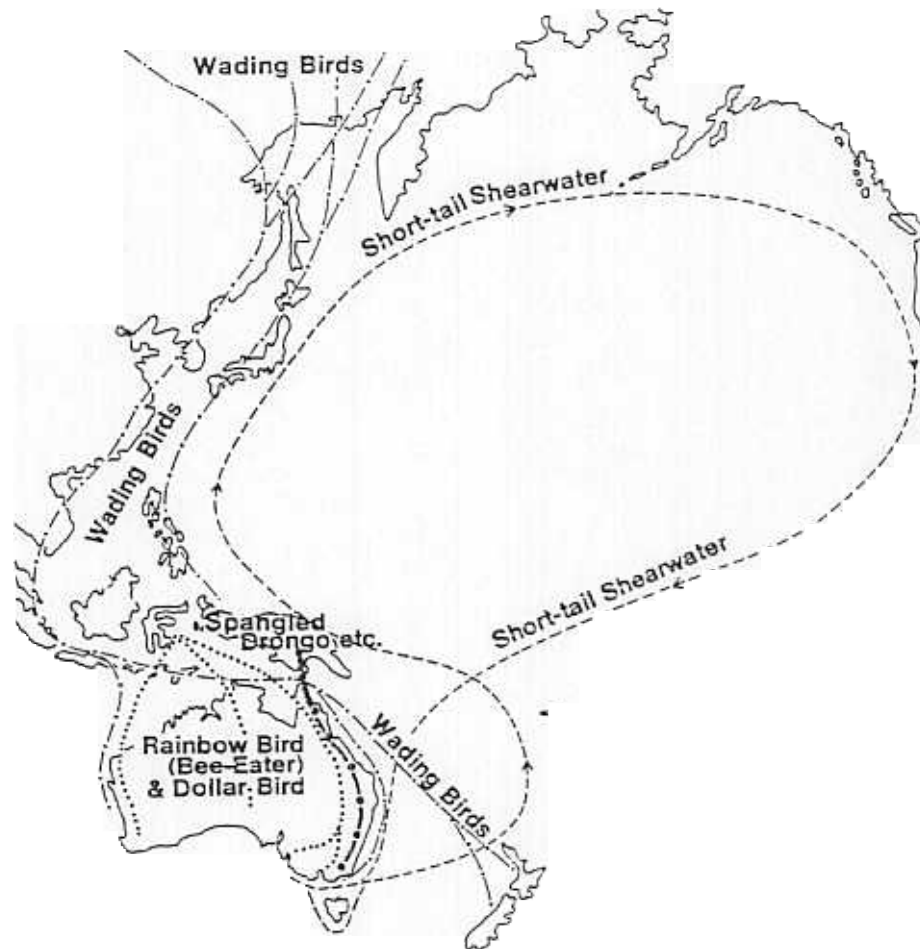


FIGURE 1. The schematic outline of the migratory routes of some of the birds visiting Australia is shown in this figure. The mutton bird (Shearwater) is of particular interest as it usually visits land only in the southern hemisphere when it returns to its breeding place.

infestations that occur on individual birds, particularly nestlings, can be very high. The ticks can be carried on birds when they leave the land, because all stages of *A. loculosum* and the immature *O. capensis* take some days to engorge before dropping to the ground. Adult *O. capensis* feed for a short time only and are rarely carried by the birds. The ticks detach after a blood meal and complete the next stage of their life cycle in the debris in, or under, the nest. Some of the pieces of land or rock infested with these ticks in the Coral Sea are barely out of water.

The few arboviruses that have been isolated are Upolu, Johnston Atoll and Saumarez Reef and these have come from *O. capensis*. There have been reports of this tick attaching to humans, as does *A. loculosum*. It is quite uncertain whether the illness associated with the attachment

TICKS AND ARBOVIRUSES IN AUSTRALIA AND ITS TERRITORIES

T.D. ST. GEORGE and D.H. KEMP

INTRODUCTION: The normal concept of Australia is of a large mainland with an island state, Tasmania, to the south of the eastern side. This view requires a considerable expansion as much of the limited success in finding viruses carried by ticks has been with ticks collected outside this limited area. None of Australia's states are landlocked and all have islands close offshore. Queensland especially has numerous islands extending in a broad zone beyond this out to the edge of the continental shelf, and to the waters close to Papua-New Guinea. Two states own islands even further out, Lord Howe Island (N.S.W.), and Macquarie Island (Tasmania). The Commonwealth has taken possession of various islets and cays in the Coral Sea among them Cato Island, Saumarez Reef, Frederick Reef, and in the Indian Ocean various reefs (e.g. Ashmore Reef), plus Cocos and Keeling Islands and Christmas Island, and in the Southern Ocean, Heard and MacDonal Islands; plus a large piece of the Antarctic mainland. Many of these possessions are uninhabited and unused. Others have manned, or unmanned weather stations. Very commonly seabirds use the islands for resting or nesting sites, and various migratory species of birds make use of them or pass by them. These islands will be referred to later.

On the mainland the cattle tick (*Boophilus microplus*) has attracted most attention because of its economic effect. It has not been found to carry arboviruses and is the least suitable species of tick of the numerous Australian tick species to do so, as it is a one host tick. An arbovirus would need to be transmitted transovarially to pass from cow to cow via *B. microplus*. There is the odd transfer of ticks from cow to cow with transmission of *Anaplasma* in this way but it is probably too infrequent for maintaining virus transmission. There are a variety of other ticks which attach to vertebrates, in their larval, nymphal and adult stages. Thus, in addition to the possibility of transovarial transmission they can transmit viruses in successive development stages on different hosts of the same, or different species. A selection of Australian ticks is listed in Table 1.

The duration of the life cycle of a particular tick species depends on the species of tick, the availability of vertebrates to provide a blood meal, and climate. In tropical areas, a tick can complete its life cycle in weeks, or months. At the other extreme an arctic tick's life cycle may extend over several years and some *Ornithodoros* ticks may survive for 6-7 years before finding another host. In either instance, the tick provides an excellent mechanism whereby an arbovirus can be carried over from one season to another, and to a new generation of vertebrate hosts. In other parts of the world, arboviruses are maintained in overwintering ticks which transmit them to a vertebrate in the following spring. Until the next following winter in addition to tick transmission there is major spread via mosquitoes. These mosquitoes die out in the autumn, leaving the tick to maintain the virus again.

The Australian ticks belong to two families and a number of genera. Their principal vertebrate hosts range widely through mammals, birds and reptiles. Some ticks are very specialized, such as *B. microplus*, others will attach to a range of vertebrates, e.g. *Ixodes holocyclus*. Man and the domestic animals can be major hosts, or sometimes are quite accidentally attacked and are not necessarily useful to the tick to complete its life cycle. The tick can damage its host in various ways; the bite can be painful; the blood meals taken in by a heavy infestation can cause anaemia; some ticks excrete toxins in their saliva which are injected into the wound made by the ticks' mouthparts; ticks can transmit protozoa, rickettsiae or viruses. Only arboviruses and certain species of tick will be the subject of further consideration. There are other species of tick additional to those in Table 1, which may be found in usual or unusual hosts, but most, if not all, viruses known to be associated with those ticks have been listed. There is no known association with a virus for most species of ticks on the list. Bird associated ticks form most of the substance of this article.

An arbovirus is a virus which replicates in a vertebrate and an invertebrate host. The normal cycle is vertebrate-invertebrate-vertebrate. This is distinct from viruses like myxomatosis which are moved mechanically from one vertebrate host to another on biting mouthparts, without replication. The "arbo" in the name arbovirus is an abbreviation for "arthropod borne" virus.

TICKS OF THE CORAL SEA: The important species of ticks here are *Ornithodoros capensis* and *Amblyomma loculosum*. These ticks live on various cays and islets that sea birds use. The tick

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of such ticks is due to a toxic effect, or an infectious agent carried by the tick. Undoubtedly technicians building and servicing automated weather stations on these cays have been ill following an attack by ticks. Saumarez Reef virus is a flavivirus (older synonym "group B"), which is a group of viruses with many members pathogenic for man so human infection is quite possible.

It is also quite uncertain whether the die-back that occurs in sea birds on some cays has any relevance to the ticks, or the associated arboviruses. Small serological surveys have shown that seabirds do become infected by the viruses so infection certainly occurs. There is scope for more work. With the development of national parks in the area, reports of attachment of ticks to man and his companion animals will increase.

TASMANIAN SEA BIRD TICKS: The distance from Saumarez Reef to Tasmania is approximately 2500 km. There is a link between the two areas via sea birds. Saumarez Reef virus (a flavivirus) was isolated from Ixodes eudyptidis ticks collected from two dead Silver gulls (Larus novaehollandiae) collected by Mr. R.H. Green of the Queen Victoria Museum, Launceston, about the same time as the ticks of a different species, and family, from which the same virus came were collected in the Coral Sea. Four of 14 sera from silver gulls in the Launceston area had neutralising antibodies in their sera. Thus again there was a link between the virus and the gull populations, but again, there is no direct evidence to connect the virus, or the ticks, with the deaths of the gulls.

THE ANTARCTIC TERRITORIES: The interest in the ticks and possible viruses in the Antarctic region was stimulated by a visit to Australia of Professor D.K. Lvov, of the Ivanovsky Institute, Moscow. He described the very high infection rate of viruses in ticks of the Behring Strait birds. It seemed that an analogous situation should exist in the Antarctic. Accordingly, with the cooperation of various scientific visitors to Macquarie Island, ticks were collected from numerous sites on the island between 1972 and 1979. All the ticks were of the species Ixodes uriae, most from habitats of Royal, Rockhopper or King Penguins. The viruses isolated were Nugget, Taggart and flaviviruses. The rate of infection of the ticks was high. The evidence that the viruses actually infected Penguins came from neutralisation tests on Penguin sera collected on Macquarie Island. Such serological surveying that has been done was quite inadequate to determine what birds, other than Penguins, were infected. Tests on sera of members of an Antarctic expedition who suffered a febrile illness were negative for antibodies to Nugget and Taggart virus. Thus, these two viruses have not been linked to a human infection.

The really significant part of the story is that both the ticks and the arboviruses on Macquarie Island have close relatives in the arctic regions, but not in the tropics and subtropics. The tick Ixodes uriae certainly occurs in the northern hemisphere, its distribution is circumpolar, and it is recorded under another name, I. putus, in Russia. It is associated with sea birds. The viruses Nugget and Taggart, belong to the Kemerovo and Sakhalin serological groups respectively. As these names suggest, related viruses occur in Russia. The link between Macquarie Island Penguins and sea birds of the subarctic cannot be a very direct one. Penguins, with perhaps the exception of one species in the Galapagos Islands, do not occur in the northern hemisphere. Some of the migratory birds which travel to the northern Pacific do not touch land there. The distribution of these two viruses, and the flaviviruses of Macquarie Island in the Antarctic is not really known, so speculation without further information is not really profitable. The close relationship of both viruses and ticks does suggest that exchange of genetic material must occur.

LAND BIRD TICKS: The only isolations of viruses from ticks collected on the mainland were from bird rookeries near Brisbane and Darwin. The rookery near Brisbane was clearly associated with land birds.

CSIRO 704 VIRUS: This virus was isolated from Argas robertsi ticks collected in a cattle egret (Ardeola ibis) colony about 100 km west of Brisbane. The ticks were plentiful under bark of trees and debris, and were also found on young birds. The virus was linked to the birds by finding antibodies to it in 8 nestlings. The virus is being classified at present at the Yale Arbovirus Research Unit in New Haven, Connecticut.

The cattle egret is a large white bird often seen feeding near cattle. It has an interesting, if uncertain, history. It is a comparative newcomer to most of Australia. The uncer-

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TABLE 1
A Selected List of Ticks Found in Australia or its Territories

Species	No. of Hosts	Major Host Species*	Viruses associated with the tick in Australia
<u>Ixodes holocyclus</u> (Australian paralysis tick) (CSIRO Handbook of Common Names)	3	Bandicoot (possum, dog, cattle, sheep, horse, human)	Nil
<u>Ixodes tasmani</u> (Common Marsupial Tick)	3	Many native animals (dog, sheep, horse)	Nil
<u>Ixodes uriae</u>	3	Many seabirds	Nugget, Taggart CSIRO 122
<u>Ixodes eudyptidis</u> (New Zealand seabird tick)	3	Penguins (many seabirds)	Saumarez Reef
<u>Ixodes kohlsi</u> (Konl's seabird tick)	3	Penguin (other seabirds, man)	Nil
<u>Ixodes auritulus</u>	3	Seabirds and land birds.	Nil
<u>Ixodes simplex</u> (bat tick)	3	Bats	Nil
<u>Boophilus microplus</u> (Cattle tick)	1	Cattle (deer, sheep)	Nil
<u>Rhipicephalus sanguineus</u> (Brown dog tick)*	3	Dogs (man)	Nil
<u>Amblyomma triguttatum</u> (Ornate Kangaroo Tick)	3	Kangaroo (cattle, sheep, horses, dogs, man)	Nil
<u>Amblyomma cyprium</u> (Feral pig tick)	3	Pig (man, immatures on birds and rodents)	Nil
<u>Amblyomma loculosum</u> (Seabird tick)	3	Sea birds (man)	Nil
<u>Haemaphysalis longicornis</u> (bush tick)	3	Cattle (sheep, horses, dogs, man)	Nil
<u>Haemaphysalis doenitzi</u> (Doenitz' Oriental-Australian bird haemaphysalid)	3	Especially ground dwelling birds	Nil
<u>Ornithodoros capensis</u> (Seabird soft tick)	3+	Gulls, penguins, terns and other seabirds	Saumarez Reef, Opuu, Johnston Atoll
<u>Ornithodoros gurneyi</u> (Inornate Kangaroo Tick)	3+	Kangaroos (horses, dogs, man)	Nil
<u>Argas robertsi</u> (Robert's bird tick)	3+	Stork, Egret, Cormorant (domestic poultry)	Kao Shuan, CSIRO 704
<u>Argas persicus</u> (fowl tick)	3+	Domestic poultry	Nil

* Occasional host records shown in brackets.

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tainty is whether it arrived as a migrant, via the islands to the north, or is descended from 18 egrets imported to the Kimberleys from India by graziers in 1933 to control cattle ticks (unsuccessfully) or perhaps both ways. The birds range as far south as Tasmania in the east and the south west of Western Australia, on the other side of the continent.

Mortalities do occur in egret colonies (Niel McKilligan, unpublished data), but nothing is known of the pathogenicity of the virus CSIRO 704. Since A. robertsi sometimes invades backyard poultry houses, infection of domestic poultry is theoretically possible.

Kao Shaun virus, a virus which belongs to the Deri Ghanzi Khan serological group was isolated from this same species of tick, A. robertsi, collected by H. Hoogstraal in a large rookery in mangroves near Darwin. This particular rookery was used as a nesting place or visited by a variety of bird species including cormorants, ibis and egrets, so has land and sea associations. A. robertsi is widespread in south east Asia. The finding of this tick on a lighthouse beacon on Young Reef, Great Barrier Reef has interesting implications for introduction of the tick and its viruses to Australia. Most, but not all, of the other viruses of the Deri Ghanzi Khan group in other parts of the world are associated with bird ticks.

POTENTIAL FOR THE FUTURE: The very few isolations of arboviruses from Australian ticks gives perhaps a false idea of the potential for them to act as vectors. The ticks from sea birds or their habitats has been most productive in relation to the small effort that has been invested by investigators, whose main line of work is concerned with viruses carried by mosquitoes or culicoides. In recent years, very little has been done to investigate whether ticks of livestock, marsupials or reptiles carry arboviruses. It is hard to imagine that this ecological niche is not occupied, as it is on other continents.

The first problem is to obtain ticks for virus isolation, than to have them identified. Ticks can be sent to Dr. D.H. Kemp of CSIRO Long Pocket Laboratories, P.B. No. 3, P.O., Indooroopilly, Queensland 4068. A large representative collection of Australian Ticks was prepared by Dr. F.H.S. Roberts, and is maintained at these laboratories. Ticks, other than cattle ticks which are in good order can be sent alive to the above address. They should be in a container with a small amount of moisture on a Kleenex tissue. They should not be crowded as their metabolic byproducts will otherwise overwhelm them in transit. Data on where, when, and by whom they were collected will assist considerably. The host, or habitat, from which they came should also be stated. After identification suitable specimens can be processed for virus isolation.

If the viability of the tick is uncertain, it should be preserved in alcohol and forwarded for identification with the same data relating to origin. Due care should be taken that the alcohol will not leak in transit.

In contrast to many other viral topics dealt with in this refresher course, most of the basic work is yet to be done. What has been described here represents only a small start. In the near future, further work on the bird ticks, especially Ixodes auritulus, I. kohlsi, Amblyomma loculosum and A. robertsi, looks the most promising.

The Argas robertsi infestation of cattle egrets was discovered by Dr. Neil McKilligan of the Darling Downs Institute of Advanced Education and we are grateful to him for his help with this work.

SELECTED REFERENCES

- BOURNE, W.R.P., BOGAN, J.A., BULLOCK, D., DIAMOND, A.W. and FEARE, C.J. (1977). Abnormal terns, sick sea and shore birds, organochlorines and arboviruses in the Indian Ocean. Mar. Pollut. Bull. 8: 154-158.
- CONVERSE, J.D., HOOGSTRAAL, H., MOUSSA, M.I., KAISER, M.N., CASALS, J. and FEARE, C.J. (1976). Aride virus, a new ungrouped arbovirus infecting Amblyomma loculosum ticks from roseate terns in the Seychelles. Archs Virol. 50: 237-240.
- DOHERTY, R.L., WHITEHEAD, R.H., WEITERS, E.J. and JOHNSON, H.N. (1969). Isolation of viruses from Ornithodoros capensis Neumann from a tern colony on the Great Barrier Reef, North Queensland. Aust. J. Sci. 31: 363-364.

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- DOHERTY, R.L., CARLEY, J.G., MURRAY, M.D., MAIN, A.J.Jr., KAY, B.H. and DOMROW, R. (1975). Isolation of arboviruses (Kemerovo group, Sakhalin group) from Ixodes uriae collected at Macquarie Island, Southern Ocean. Am. J. trop. Med. Hyg. 24: 521-526.
- HOOGSTRAAL, H., KAISER, M.N. and McCLURE, H.E. (1974). The subgenus Persicargas (Ixodoidea: Argasidae: Argas) 20. A. (P.) robertsi parasitizing nesting and wading birds and domestic chickens in the Australian and Oriental regions, viral infections, and host migration. J. med. Ent. 11: 513-524.
- HOOGSTRAAL, H., WASSEF, H.Y., CONVERSE, J.D., KEIRANS, J.E., CLIFFORD, C.M. and FEARE, C.J. (1976). Amblyomma loculosum (Ixodoidea: Ixodidae): identity, marine bird and human hosts, virus infection and distribution in the southern oceans. Ann. ent. Soc. Am. 69: 3-14.
- READER'S DIGEST. (1977). Complete Book of Australian Birds. Reader's Digest Services, Sydney.
- ROBERTS, F.H.S. (1970). Australian Ticks. CSIRO, Australia.
- ST.GEORGE, T.D., STANDFAST, H.A., DOHERTY, R.L., CARLEY, J.G., FILLIPICH, C. and BRANDSMA, J. (1977). The isolation of Saumarez Reef virus, a new flavivirus, from bird ticks Ornithodoros capensis and Ixodes eudyptidis in Australia. Aust. J. exp. Biol. med. Sci. 55: 493-499.