A SURVEY OF BLOOD-SUCKING AND SYNANTHROPIC DIPTERA AND DUNG INSECTS ON NORFOLK ISLAND, SOUTH PACIFIC

P. FERRAR, H. A. STANDFAST and A. L. DYCE

Division of Entomology, CSIRO, Canberra, A.C.T. 2601, Australia.
Division of Animal Health, CSIRO, Long Pocket Laboratories, Indooroopilly, Qld. 4068. Australia.
Division of Animal Health, CSIRO, McMaster Laboratory, Glebe, N.S.W. 2037. Australia.

Abstract

Annotated lists of Culicidae (4 spp.), Ceratopogonidae (14), Simuliidae (1), Gasterophilidae (1), Muscidae (7), Calliphoridae (5) and Sarcophagidae (3) are given from collections made on Norfolk Island during April 1972, with notes on 3 other pest groups. The cow dung fauna of the island is also listed. It was found to lack any efficient dung-dispersing organisms.

Introduction

Norfolk Island (Fig. 1) is an isolated island in the south Pacific Ocean, at latitude 29°S and longitude 168°E. Its lies 670 km from New Caledonia, 770 km from New Zealand, 900 km from Lord Howe Island, 1360 km from Australia and 1625 km from Fiji. The island is about 8 km long and 5 km wide, with a total area of 3450 hectares. The coastline of about 32 km consists mainly of precipitous cliffs. The average elevation of the island is 100 m, with two peaks rising to just over 300 m. The soil is a friable red earth of volcanic origin, rich in clay but quite porous.

The climate is subtropical and equable, with the recorded temperature extremes being 7°C to 32°C. The average annual rainfall is 1350 mm (53 inches) spread fairly evenly through the year but with a maximum in winter. Part of the island is covered with forest, including a small remnant of the indigenous forest, but much of it has been cleared for agriculture, grazing or building.

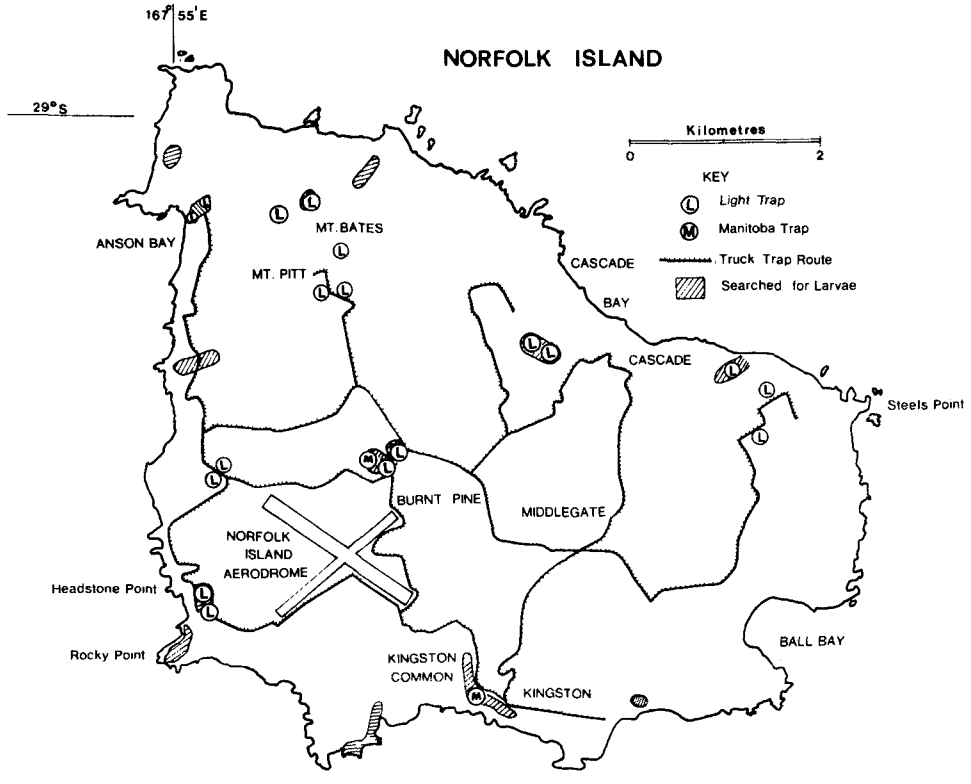

FIG. 1. Norfolk Island showing main collecting sites.

Two small uninhabited islands, Nepean Island and Philip Island, lie immediately to the south of the main island. Norfolk Island is served by air from Sydney and Auckland, and by boats that call at Australia, New Zealand and various Pacific islands. Further general information on Norfolk Island is given by Turner *et al.* (1968). Some insects collected on the island are listed by Hawkins (1942) but only certain orders are listed in detail. Diptera are only identified to families, with the exception of one record of *Culex fatigans*. Hawkins also gives references to earlier literature on Norfolk Island insects. Mosquitoes are listed by Belkin (1962), and a simuliid by Dumbleton (1969). Muscidae known from Norfolk Island, including those collected during this survey, are listed by Pont (1973).

This survey originated from a request by the Administrator of Norfolk Island for a release of dung beetles (Coleoptera: Scarabaeinae) on the island, as part of CSIRO's dung beetle project (Ferrar 1973) for preventing the accumulation of cow dung in pastures and for controlling dung-breeding flies. The survey was planned to study the dung fauna of the island and the likely effect upon it of the introduction of exotic dung beetles, but the opportunity was taken to widen the survey to include all synanthropic and blood-sucking flies on the island. The survey was conducted from 12 to 26 April 1972.

Methods

Adult insects were collected from dung pads, livestock, carrion, garbage and vegetation, and around standing and running water. Baits of dung and rotting fruit were laid in forest areas to attract adult insects restricted to these habitats.

Dung-breeding insects were sampled by collecting 10 cm diameter cores of dung, placing these on sand in individual containers, and breeding out the adult insects. Larger fly larvae were also collected individually and reared to adults. Fly pupae were collected from beneath dung pads, carrion and litter bins, and from an imported livestock crate, and were reared to adults. Aquatic larvae and pupae were collected from all types of still and running water, including marine rock pools, leaf axils and tree-holes.

Light traps of the type described by Dyce *et al.* (1972) were operated in various areas on most nights. One type was designed to collect mosquitoes and smaller insects, the other screened out mosquitoes and collected only very small flies. A truck trap of the type described by Dyce *et al.* (1972), mounted on a Mini-Moke, was operated at dawn and dusk on most days. Runs were for 30 min at 24 km/h. A Manitoba trap was operated in open pastures for the first 3 days, but was then damaged by high winds.

All methods of collecting were used in as wide a selection of vegetation types as could be found. It should be noted that the time of the survey was not ideal; temperatures, particularly at night, were low and wind velocities were high, so that activity of crepuscular species was depressed. Where possible sheltered collecting sites were selected but in many cases the sites were exposed.

All material has been lodged in the Australian National Insect Collection.

Collections

DIPTERA

Family Culicidae

Culex (Culex) fatigans Wiedemann: Widespread, and the most numerous mosquito on the island. A domestic pest, also abundant in poultry houses. Breeding in water collected in containers and in polluted ground waters. A cosmotropical species, presumably introduced.

Culex (Culex) sp. nr. *pervigilans* Bergroth: Less abundant than *C. fatigans*. Breeding in ground pools; probably indigenous.

Aedes (Halaedes) australis (Erichson): Abundant around the shoreline, breeding in saline rock pools. Also known from Lord Howe Island and New Zealand, and

from Australia where it is known to feed on birds and mammals, including man. This species is facultatively autogenous (Woodhill 1936).

Aedes (Ochlerotatus) sp. nr. *antipodeus* (Edwards): Breeding in ground pools in remnants of indigenous forest. Probably an indigenous species, and unlikely to be of medical or veterinary importance. Adults were not collected despite protracted searching; those studied were bred from larvae.

Family Ceratopogonidae

Culicoides sp.: A single undescribed species was taken, almost certainly indigenous and not likely to be of medical or veterinary importance. The dung-breeding *C. brevitarsis* Kieffer, an important pest of cattle in Australia which has reached Lord Howe Island and Fiji, was not taken. The trapping and breeding methods used should have returned this species had it been present (Dyce and Murray, unpublished data).

Other Ceratopogonidae collected were *Atrichopogon* (1 sp.), *Forcipomyia* (3), *Dasyhelea* (4), *Alluaudomyia* (3), *Monohelea* (1) and *Bezzia* (1), none of which feeds on vertebrates.

Family Simuliidae

Simulium ornatipes norfolkensis Dumbleton: An indigenous subspecies with a close relative in Australia (Dumbleton 1969). Immature stages were collected from rocks, leaves and trailing grass in most streams on the island. Feeding habits unknown, but unlikely to be of medical or veterinary significance.

Family Psychodidae

Large numbers of unidentified Psychodinae were collected in light traps and truck traps, but Phlebotominae appeared to be absent.

Family Tabanidae

Some residents of Norfolk Island claimed to have seen Tabanidae on the island, but none was taken despite vigorous searching. Since beaches provide characteristic breeding sites of certain species in other countries, it may be significant that reports of tabanid activity were centred on the only two sandy beaches on the island.

Family Gasterophilidae

Eggs of *Gasterophilus intestinalis* De Geer were collected from the legs of a horse. A larva of the same species was recovered from a horse recently introduced to the island.

Family Muscidae

Musca domestica L.: Abundant throughout the island, and a nuisance in kitchens and around food. Two adults were also noted feeding around the eyes of a stud bull. A cosmopolitan pest, presumably introduced.

Stomoxys calcitrans (L.): Very abundant, mainly attacking livestock but also humans. A cosmopolitan species, perhaps brought to Norfolk Island with imported livestock. Many adults were collected basking on vegetation, stones, etc., and some on the carcass of a calf. Between 30 and 40 adult flies were counted on one side of a stud bull in one pasture, and the flies were causing obvious worry to most stock. Adults were reared from larvae collected in heaps of composted grass, and, on one property, from a few heavily shaded cow dung pads under a spreading tree. The larvae in these pads were enormously abundant and overcrowded, and produced very stunted adults. Undisturbed cow pads are not normally a breeding medium for this species.

Australophyra rostrata (Robineau-Desvoidy): One specimen was bred from a pupa found under a litter bin. Also known from Lord Howe Island, and widespread in Australia, where it is a tertiary sheep blowfly.

Synthesiomyia nudiseta v.d.Wulp: Collected on dung, on carrion and at garbage bins. Moderately common throughout the island, where it may breed in garbage and meaty refuse as in many other countries. Cosmotropical, presumably introduced.

Fannia sp. n. A: Common throughout the island. Attracted to dung and to carrion; also frequently settling on humans to feed on sweat, and sometimes mildly irritating through their persistence, like the Australian bushfly (*Musca vetustissima* Walker). Known from Norfolk and Lord Howe Islands only.

Fannia sp. n. B: Common throughout the island. Habits similar to species A above. Apparently indigenous to Norfolk Island. These two species are those referred to as A and B by Pont (1973).

Euryomma peregrinum (Meigen): One male was taken. Distributed throughout the Old World tropics, and presumably introduced.

The breeding places of the three species of Fanniinae were not found. Apparently none breed in cow dung, but it is possible that some breed in the many septic tanks (there is no mains sewerage system on the island). Pont (1973) suggests that the larvae are scavengers, possibly in birds' nests.

Seven other species of Muscidae were collected, but are thought to be of no economic importance. They are listed by Pont (1973).

Family Calliphoridae

Calliphora stygia (Fabricius). Common all over the island. Collected on carrion and on dung, as adults only. Also known from Australia and New Zeland, and presumably introduced.

Calliphora norfolka Kurahashi: Abundant all over the island. Collected on carrion and on dung, and bred from larvae in a dead bird and pupae found under an unemptied litter bin. Apparently indigenous to Norfolk Island.

Calliphora sp.: One specimen was taken of an apparently undescribed species.

Lucilia sericata (Meigen): Fairly common on the island. Collected on carrion, and bred from a dead bird. An almost cosmopolitan species, presumably introduced.

Chrysomya varipes (Macquart): Collected on carrion and in a light trap, as adults only. Also recorded from south east Asia, Australia and some Pacific islands.

Enquiries revealed that there were at the time of the survey 42 sheep on Norfolk Island. Two of the calliphorids (*Lucilia sericata* and *Calliphora stygia*) can under some circumstances be important primary sheep blowflies, and *Chrysomya varipes* and the muscid *Australophyra rostrata* have been recorded as secondary and tertiary sheep blowflies respectively. However, sheep-owners reported that they had no trouble with blowfly strike on their animals, and they could not remember any such problem on Norfolk Island.

Family Sarcophagidae

Hybopygia varia (Walker): The dominant sarcophagid on the island, and one of the most abundant of all flies there. Collected on dung, on carrion, on garbage, on vegetation, and also settling on humans on whom it was sometimes a nuisance. Observed depositing larvae in fresh cow pads on several occasions, and reared in good numbers from cow dung collected in several parts of the island. Dung is clearly its main if not sole breeding medium. The species is common in parts of South America, and is also recorded from New Zealand, from where it may have been introduced to Norfolk Island. It is not known from Australia.

Boettcherisca peregrina (Robineau-Desvoidy): Attracted to decomposing materials, but not particularly abundant. Bred from pupae collected under an unemptied litter bin. Widespread in the Oriental Region and common in Australia and Fiji.

Tricholioproctia epsilon (Johnston and Tiegs): Attracted to decaying materials,

but not very common. Two adults were reared from pupae collected under an unemptied litter bin. Previously known only from Australia, whence it has presumably been introduced to Norfolk Island.

OTHER ARTHROPODA

Fleas were reported to be common and pestilent to humans. A sample of *Ctenocephalides felis* (Bouché) was combed from a domestic cat. Lice were reported to be abundant on cattle and on pigs, but no opportunity arose for samples to be collected. A single tick taken from a cow was donated by a local resident, and was identified as *Haemaphysalis longicornis* Neumann, a species previously recorded from the island. The tick is reported to be rare on the island, and generally restricted to cattle grazing in cliff-top areas where mutton-birds burrow.

Many of the muscoid fly pupae collected were parasitized by a wasp, *Tachinaephagus* sp.

Observations of dung fauna

Cattle far outnumber sheep and horses on Norfolk Island, and cow dung is abundantly spread on all grazing areas, including Kingston Common where the cattle graze among the historic buildings. Pads marked at the beginning of the survey showed no appreciable destruction twelve days later, and many pads littering pastures were obviously much older than this. No organisms were found that were efficiently burying cow dung, and it seemed that most pads eventually disappeared by rotting in Norfolk's relatively damp climate.

This survey originated from a request for the introduction of exotic dung beetles to the island, and collections of dung insects were made at several sites to determine the present fauna. The insects collected are listed in Table 1.

TABLE 1

INSECTS ASSOCIATED WITH DUNG ON NORFOLK ISLAND.

Species	In or on dung	Bred from dung	Comments
Diptera			
Sepsidae			
Sepsis albopunctata Lamb	×	×	Known from Australia and probably introduced
Parapalaeosepsis plebia (de Meijere)	×		
Sphaeroceridae			
Leptocera sp.	×	×	
Copromyza sp.	×		
Sarcophagidae			
Hybopygia varia	×	×	See text
Muscidae			
Stomoxys calcitrans	×	×	Breeding may be exceptional (see text).
Coleoptera			
Scarabaeidae			
Aphodius lividus Olivier			Caught in light traps but not in dung. A cosmopolitan species.
Heteronychus arator Fabricius	×		Not attacking the dung; a South African species introduced to Australia where it is a pest in places.
Staphylinidae			
Philonthus longicornis Stephens	×		Widespread in the world and probably introduced
Hydrophilidae			
Cercyon haemorrhoidalis Fabricius	×		Widespread in the world and probably introduced

Hawkins (1942) records *Ataenius* sp. (Coleoptera: Aphodiinae) from Norfolk Island, but it was not collected during the present survey. No Scarabaeinae (true dung beetles) were found anywhere on the island, although conditions were ideal for their activity. It seems likely that no such species were present on the island at the time, which would account for the lack of dung pad dispersal.

Discussion

Origin of the fauna

The origins of the faunas of oceanic islands pose problems for zoogeographers. Recent papers based on studies of plate tectonics (Griffiths 1971; Raven and Axelrod 1972) are relevant to the origins of the Norfolk Island fauna. These works postulate that disruption of the Australian plate in the Cretaceous Period was completed by the opening of the Tasman Basin some 50 million years ago, while the separation of New Zealand from Norfolk Island and New Caledonia followed the foundering of the Norfolk ridge some 35 million years ago. The Norfolk Island fauna would thus be expected to have a greater affinity with that of New Zealand than with that of Australia.

The *Culex* sp. nr. *pervigilans* and *Aedes* sp. nr. *antipodeus* are in fact closely related to New Zealand species. *Aedes australis* is present on Lord Howe Island and in New Zealand, Tasmania and the south-east coast of Australia, and the similarity of the four isolated populations (E. N. Marks, personal communication) suggests that the spread occurred in comparatively recent times. The simuliid, however, is related to an Australian species. The affinities of the other apparently indigenous species of Diptera are not at present clear. It seems likely that yet other indigenous species failed to survive the marked ecological changes that swept the island since its colonisation by European settlers in 1788.

Most of the insects listed above have clearly been introduced by man, which is not surprising since some are more or less cosmopolitan pests that accompany man wherever he colonises, and others are insects particularly associated with the dung of large herbivores and would have had no ecological niche until cattle and horses were brought to the island (the only indigenous mammal being a bat). Most of the calyptrate Diptera fall into these categories, and also the mosquito *Culex fatigans*. It is difficult to explain the absence of *Aedes aegypti* (Linnaeus), as the island appears to present a very suitable habitat for this widely distributed species.

Some of the pests could perhaps have been kept out by better quarantine precautions, though they may have been introduced during the settlement of the island when the importance of quarantine was not realised. During the survey a wooden crate containing two horses shipped from Sydney was landed at Kingston wharf; after the horses had been released most of the straw and dung was removed to be burnt, but enough remained in the grooves of the slatted floor to retain breeding stages of flies. Thirteen pupae were found there, and one larva had migrated on to the wharf and was about to pupate in a crack in the stone. All subsequently produced *Musca domestica* adults. Similar importations of livestock could introduce other pests such as the Australian bushfly *Musca vetustissima* Walker.

Dung accumulation

The accumulation of dung in grazing areas on Norfolk Island is frequently remarked upon by visitors, especially around the historic buildings at Kingston where dung pads lie through many of the most visited ruins. As reported above, the island has no fauna capable of dispersing this dung, and introduction of exotic scarabaeine beetles adapted to bovine dung could be beneficial for several reasons (Ferrar 1973). There are no indigenous dung-dwelling insects that would be threatened by the exotic introductions.

The main benefits would be pasture improvement and aesthetic gain. Rapid burial of pads restricts fly breeding, but this would probably be of less significance on Norfolk Island. The sarcophagid *Hybopygia varia* should be reduced in numbers, but

appeared to be only a moderate nuisance. The stable fly *Stomoxys calcitrans* was found to be breeding in cow pads in one area, but this was probably exceptional.

We might add that two attempts have now been made to introduce such beetles. On 4 September 1972, a shipment of insectary-bred dung beetles (500 *Onthophagus gazella* Fabricius and 500 *O. binodis* Thunberg) from CSIRO in Canberra, Australia, was released on Kingston Common, but an exceptional period of drought after the release apparently prevented establishment. On 24 May 1974 110 *O. binodis*, 400 *Onitis alexis* Klug, 400 *Euoniticellus africanus* Harold and 500 *E. intermedius* Reiche (a drought-tolerant species) ex Canberra were released at several locations on Norfolk Island, and the result of these introductions is awaited with interest.

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