MEAT & LIVESTOCK
AUSTRALIA

On farm

Dung Beetle Survey of South East Queensland

NAP3.320
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ISBN 1 74036 222 5

January 1999

Natural Resources

FORWARD

The Taroom Landcare Group had established the need for the survey by hosting two information seminars in June 1998. "Soilcam" was the information provider. In excess of 110 producers and agency staff attended the two seminars, showing outstanding support for the role of Dung Beetles. The meetings called for more information that can only be provided by carrying out a full series of surveys across Queensland.

The survey was carried out following acceptance of the proposed budget by Soilcam, Dung Beetle Consulting of Canberra, managed by John Feehan. Mr Feehan had extensive experience at CSIRO from 1965 to 1991, with the introduction of 50 species of dung beetle into quarantine, the rearing and release of 44 species throughout Australia and the mass harvesting of some species for re- distribution in some areas of Australia.

Since the closure of the program at CSIRO in 1993, John Feehan and his family have been operating "Soilcam" as a Dung Beetle Consultancy and Supplier of Dung Beetles.

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Sponsored by

Taroom Shire Landcare Group
Springwater Producer Group
Gympie Beef Liaison Group
Meat and Livestock Australia

TABLE OF CONTENTS

FORWARD 1
INTRODUCTION 3
SUMMARY 4
BEETLE SAMPLING METHOD 4
RESULTS AND DISCUSSION 5
Description of pit-fall trap 7
Description of Flotation Technique 8
Mites 8
Interesting finds of introduced species 8
An interesting find of a native species. 9
RECOMMENDATIONS 9
Onthophagus obliquis 10
ACKNOWLEDGEMENTS 11
APPENDIX 1 12
PHOTOS 12
APPENDIX 2 14
SURVEY RESULTS 14

INTRODUCTION

In mid 1998, Mick Alexander of the Taroom Shire Landcare Group, requested the services of "Soilcam" Canberra to carry out a Survey of South East Queensland to ascertain the establishment of introduced Dung Beetles. The survey was carried out from 7 January 1999 to 18 January 1999 and was sponsored by Meat and Livestock Australia, Taroom Shire Landcare Group, Springwater Producer Group & Gympie Beef Liaison Group.

Of the 44 species of Exotic Dung Beetle released from 1965 onwards, 30 species are known to be established and it is believed that only one species *Euonoiticellus intermedius* has reached its climatic and geographic limits. A second species *Onthophagus gazella* is well spread throughout the northern part of the continent and is continuing to move south in Eastern Australia. It can be found at locations near the Murray River.

Some of the other 29 species are established in areas, which may be only 20 to 50 km in diameter. It could take some of these species many decades to spread by natural movement to their climatic boundaries.

Soilcam's objectives are to spread the introduced species established in Australia to their climatic and geographic limits, to maximize the benefits of reducing buffalo fly numbers as well as the many other benefits dung beetles can produce for agriculture throughout Australia.

The aim of the survey was two fold :

To survey as many sites as possible in the time allocated between advertised dung beetle presentations to cattle producers.

To demonstrate two dung beetle sampling techniques to cattle producers to enable and encourage cattle producers to continue sampling over a much wider area and over a longer period.

This report details the survey procedures, results and some recommendations

SUMMARY

The Dung Beetle Survey was carried of from 7 January to 18 January 1999, while travelling between 18 locations in South East Queensland (see site map, Appendix 2). Dung Beetle presentations were carried out at the following venues:

Jackson, Wandoan, Graton, Theodore, Bauhinia, Injune, Roma, St George, Rolleston, Capella, Rockhmapton, Wowan, Thangool, Gympie, Harland, Crows Nest, Chinchilla, Billa Billa.

The survey was designed to:

- Check Dung Beetle activity at 47 sites while travelling the 4,500 km (see survey sheet Appendix 2).
- The species of introduced beetles were identified on return to Canberra as well as the native species.
- To demonstrate to the cattle producers two techniques of sampling beetles from their cattle station for future identification.
    a) The flotation method - collecting all beetles from a single pad.
    b) The setting up of a Pit-fall trap - collecting beetles over a 24 hour period.
- Promoting the other benefits dung beetles produce for agriculture in general.

BEETLE SAMPLING METHOD

The allocation of time between the 18 presentations coupled to the distance between each venue, which ranged from 150 to 480 km limited the time for a comprehensive beetle survey.

1. When cattle were sighted in a paddock the coordinates were recorded using global positioning satellite recording device.
2. The location and approximate direction from the last town was recorded.
3. The Station name was recorded (if known).
4. At each site the two collectors spent between 30 and 40 minutes working separately, locating cow pads and collecting introduced and native dung beetles for identification.
5. When suitably aged dung pads could be found the maximum and minimum number of each dung beetles species was estimated and recorded.
6. An estimate of the average percentage burial was recorded.
7. A rough estimate of the soil type was recorded.

8. Fly larvae in dung pads were recorded, the larvae of the "bottle green" dung fly *Orthellia lautha* and bush fly larvae *Musca vetustissima* were not differentiated between, and were recorded as fly larvae. Both species require about five to seven days in cow dung to complete their larval stage. Larvae of the buffalo fly larvae *haemotobia irritans exigua* are quire small and difficult to find, they were not seen in any cow pads. The buffalo fly larvae require four to five days to complete their larval stage.

9. Bush fly numbers were recorded at each site by counting the total number of flies that had been attracted to the two surveyors. It was estimated that at each site, the total period spent walking in a paddock was 70 minutes. Up until site 41, there had been a total of only 36 flies attracted to the two surveyors working outdoors over a total period of 48 hours in January 1999, where estimates of cattle numbers range from 6 to 8 million.

RESULTS AND DISCUSSION

A summary of the species collected is given in the tables in Appendix 2. There were 13 introduced species collected during the survey and one introduced predacious species, *Hister nomas*. The adult beetles feed on fly larvae in a cow pad, the female lays eggs under the pad, the *H. nomas* larvae find and feed upon fly larval in the pad and also find and feed on fly puparia in the soil surrounding a pad.

List of 13 introduced species found during the survey, one predacious species and seven native species.

- *Euoniticellus africanus*
- *Onitis alexis*
- *Onthophagus gazella*
- *Onthophagus binodis*
- *Copris elphenor*
- *Euoniticellus intermedius*
- *Liatongus militaris*
- *Onthophagus nigriventris*
- *Onitis pecuarius*
- *Sisyphus spinipes*
- *Sisyhpus rubrus*
- *Onthophagus sagittarius*
- *Onitis viridulus*
- *Hister nomas* (predatious species feeds on fly larvae)

Native species

- *Onthophagus atrox*
- *Onthophagus australis*
- *Onthophagus dandalu*
- *Onthophagus pugnacior*
- *Onthophagus quinquetuerculatus*
- *Onthophagus thoreyi*
- *Onthophagus wakelbura*

The extremely low numbers of bushflies attracted to the two surveyors throughout the survey until site 41 is worthy of comment.

A single cow pad of good quality dung can produce more than 2000 bushflies, the 36 bushflies counted up to site 41 is testament to the dung beetles rapid burial of dung during the 4500 km of travel over the eleven days.

Bush fly numbers at times can be greatly reduced even when cow dung is not totally buried. During dry hot periods, low levels of burial and dung disturbance can lead to desiccation of dung occurring in less than three or four days, which is sufficient to prevent larval development.

After speaking to many of the 400 cattle producers who attended the Dung Beetle presentations, not one producer was currently using any chemical means to control buffalo fly. There is a great deal of anecdotal evidence gathered from cattle producers from well over a decade, indicating that when dung beetles are active enough to bury cow dung quickly, buffalo fly numbers are reduced to a level where little or no chemical control is required.

Producers did comment that buffalo fly were worrying cattle during spring 1998 and some had embarked on chemical control measures, however, they stopped using control measures when the beetles became active in early summer.

Personal contact with CSIRO staff who had worked on the dung beetle buffalo fly program in Queensland have stated that buffalo fly survival during experimental work had been reduced by 80% and 90% due to dung beetle activity at times.

Fluctuations in buffalo fly numbers could be due to some of the following reasons:

a) Weather conditions not conducive to high levels of dung beetle activity.

b) Buffalo fly can breed in an area where dung beetles were not present or active and get blown into another area.

c) Dung Beetles were carefully selected to bury dung in open areas. The broad reason was that the introduced species would not compete or surpress endemic species that generally breed in scrub and bush habitats. It is not known if cow dung dropped in scrub and bush areas or under the canopy of trees or in lightly wooded areas, where introduced species prefer not to habitat, is responsible for producing the buffalo flies in an area when dung beetles are active in open pasture areas.

Site No. 44, 15km North Toowomba at Spring Bluff had eight species of dung beetles active plus *H. nomas*. Mr Feehan was not aware of another site with as many species active anywhere in Australia. Dung burial in an estimated 24 to 36 hours was almost complete at 90% to 95%. Not a single buffalo fly was observed on a herd of 25 head of cattle at this site.

The ball rolling dung beetles, *S. spinipes* and S*. rubrus* were very active at some of the sites assessed. Both species are capable of completely removing cow pads in a day without any assistance from tunneling species. Both species however, are dependent upon showers of rain every 7 – 14 days for optimum breeding conditions and maximum dung removal.

S. spinipes leaves its dung balls on the surface of the ground and *S. rubrus* bury its dung balls in shallow holes. The level of moisture in the dung ball made by the parent female is insufficient to allow complete larval development in hot dry conditions. The additional moisture from rain softens the dung enough for developing larvae to complete the larval stage. The beetles roll the balls for 10 – 15 metres at times. *S. spinipes* position the balls at locations in long coarse grass, fallen branches, against fence posts and tree trunks, the position where the balls are placed are also locations where the balls are least likely to get trodden upon by grazing stock.

Once the female has positioned the ball, she excavates a hole, lays an egg and closes the egg chamber, forming a small nodule in the process. Buffalo fly larvae have never been found in these balls. The balls the beetles roll with ease are 29 times heavier than the beetle.

To assist in the awareness of the survey and producer discussions, advertisements were placed in newspapers and over ABC radio. The radio announcements helped notify cattle producers which transect we were traveling over each day. A 15-minute interview was also conducted on the 25/1/99.

Description of pit-fall trap

The trap is the type used by CSIRO throughout Australia for experimental assessments of beetle numbers. The trap consisted of:

1. A metal cylinder 250mm in diametre and 300mm in length.

2. A PVC funnel 210mm in diametre and 200mm in length.

3. Metal sheeting 350mm x 350mm with a 210mm hole in the centre to accommodate the funnel.

4. Wire mesh approximately 250mm x 250mm to hold the dung bait.

5. Nylon netting approximately 400mm x 400mm.

6. A length of string 400mm long.

7. A suitable container eg. Large coffee jar with a hole cut in the lid to accommodate the funnel is ideal to collect beetles.

A location in an open cattle-grazing paddock should be selected. The pit-fall trap should not be placed close to bush, scrub, and fences or under the canopy large trees. The introduced beetles were carefully selected work in open pasture areas.

A hole needs to be dug and the cylinder placed into the ground for ease of repeated use.

Collect approximately one litre of fresh dung, ten live beetles can be added to the dung. The dung is wrapped in the piece of netting and tied with string. The enclosed beetles help prevent a crust forming, which allows the dung odour to continue to be released over a longer period. The surplus netting needs to be cut off close to the string tie, to prevent beetles getting tangled.

The piece of metal sheet holds the funnel in place and also acts as a platform for beetles to land and walk towards the bait. Holes at the edge of the metal should be filled with soil to prevent the beetles digging in under the trap.

Description of Flotation Technique

Dung pads need to be selected which are at least 24 hours old. These pads will have attracted both night and day flying species. Beetles are present if there are fresh soil casts around the pad. Walk quietly to the pad as beetles quickly dive down their tunnels. A long handle shovel should be used to scoop up the dung and 5 centimeters of soil under the dung pad. The soil, grass, and dung should be tipped into approximately 10 litres of water in a bucket. Agitate with the shovel in the bucket to break up both the dung and soil. Allow a few minutes for the beetles to float to the surface for collection. Place the beetles in a tin or jar and kill with hot water. Dry the beetles for two to three days on a sheet of newspaper. Place beetles into match boxes (not sealed containers) without cotton wool.

The flotation method is the only sure way of collecting all dung beetles in a pad; an unskilled person would have extreme difficulty locating some species in dung due to the extraordinary ability to camouflage themselves when disturbed by a possible predator. All collected beetles must have an accurate label with date, exact location, name, address and phone number.

Mites

Mites were not collected during the survey. The most efficient method of collecting mites, which hitch a ride on the underside of dung beetles, is to net dung beetles in flight, flying to fresh dung. Once beetles arrive at fresh dung the mites immediately release their grip on the beetles and seek fly eggs to feed upon. The allocation of time on this survey did not allow for the extra time needed to net beetles. It is highly likely due to earlier surveys by CSIRO that the only introduced predatious mite *Macrocheles peregrinus* is established in the area surveyed.

Bush fly *M. vetustissima* breed in cattle, human and dog dung, with cattle dung being the major breeding medium. This fly is attracted to people as well as other animals seeking protein from perspiration, tears and saliva. The female fly lay clusters of 50 – 60 eggs in crevices and holes in dung. The larvae require five to seven days to complete their larval stage. The low number of flies encountered during the survey is consistent with the fact that when dung beetles are numerous and active, bush fly numbers and breeding can be surpressed greatly. CSIRO research in Western Australia revealed an 88% reduction in fly numbers attracted to humans and 99% reduction in survival from the fly egg to adult. These results were achieved when two species of introduced dung beetles were active in the research region.

Interesting finds of introduced species

O. binodis was recovered at sites 39, 40 and 41, North and South of Crows Nest, and at site 44, 15km E.N.E. Toowoomba. There appears to be potential to spread this species to similar climates in SE Queensland. Soilcam has harvested this species in tens of thousands and could supply release colonies if required. *O. binodis* often becomes active in spring in some areas of NSW.

E. africanas was recovered at site 41, SW of Crows Nest. The recovery of this species is the first recovery in Queensland. There appears to be potential to spread this species to similar climates in Queensland. The species is established in the New England are of NSW and further south, the species is very difficult to harvest and has never been harvested by Soilcam or in large numbers by CSIRO.

O. pecuarius was recovered at site 41, 38km SW of Crows Nest and site 44, 15km E.N.E. of Toowomba. This species is established in some areas along the NSW coast from Moruya to the Queensland border where it is well established over thousands of square kilometres. In some years the species has been harvested by Soilcam in the thousands.

C. elphenor was recovered at site 28, 4km NE of Wowan on “Dundee” Station and at site 29, 30km N.N.W. Biloela on “Greenfields” Station. This large species is capable of taking large quantities of dung underground. No more than one pair were found in some pads at “Greenfields” The species is probably climatically suitable for large areas of South Eastern Queensland, unless the species is found in much larger numbers harvesting would be very difficult.

An interesting find of a native species.

O. wakelbura was found at site 20, 44km NW Rolleston, and at site 24, 5km SW of "Peak Downs" This small 6mm in length, native species with red or maroon elytra was found in numbers ranging from 6 – 20 per cow pad. Over 40 specimens were collected and 36 were passed on to the Australian National Insect Collection at CSIRO Canberra, the collection contained a mere four specimens including the male Holotype, collected by Dr G.F. Bornemissza, 16km South of Capella, Queensland in 1965. The British Museum of Natural History has only one specimen.

RECOMMENDATIONS

1. The continuation of collecting samples of beetles for identification by interested parties, eg, Cattle Producers, Landcare groups, and School students should be encouraged. Soilcam suggest sampling beetles through two full seasons at least, commencing in October and continuing until April the following year. After positive identification, the locations and species should be recorded electronically, for the eventual mapping of the possible spread of each species. By using the CSIRO computer-modeling programme, CLIMEX, it is possible to predict the potential distribution of every dung beetle species throughout Queensland.

2. If a species is moved into a new area, releases of at least 1000 beetles should be considered to maximise the possibility of a colony becoming established. Soilcam releases more than 1500 beetles in a starter colony.

3. Dung beetles should be part of an integrated control system, which can reduce buffalo fly numbers through the rapid burial of dung. Other measures include:

    - Building in genetic resistance to cattle through breeding programs.
    - The use of the CSIRO buffalo fly trap.
    - The rotational use of insecticidal ear tags, eg. "Optimizer" and "Python".
    - Maximising the benefits to agriculture in general by spreading dung beetle species within their respective geographic and climatic regions.

The following list of sites is where species of beetles have been released, but not recovered. These locations should be given special attention and if possible pit-fall traps could be used for long term monitoring. There is no need to collect beetles at the exact release location. Trapping could take place within five to ten km. of the release site.

Location of Release

Species

8km SE Taroom……..*Onitis uncinatus*
16km SW Moura……*Onitis deceptor*
20km SW Roma……*Onitis westermanni*
10km SE St George……*Copris incertus*
20km N Capella……..*Onitis westermanni*
27km NW Rockhampton……*Copris diversus*
……*Allogymnopleurus thalassinus*
16km N Biggenden……*Onitis westermanni*
16km SE Gayndah……..*Onitis westermanni*
10km & 12km N Toowoomba……*Onitis crenatus*
……*Onitis vanderkelleni*
……*Onitis caffer*

This is a preliminary report, detailing the findings during a brief survey over a 13 day period in South East Queensland. If further action is contemplated following from the survey and information in this report, sound scientific advice should be sought.

Onthophagus obliquis

The species was released at seven sites in Queensland between Cape York and Rockhampton from January 1976 to November 1977. The species was found to be well established in April 1980 at Cooktown, it is a medium sized beetle approximately 15 mm in length. Mr Feehan assisted with the breeding of the species at CSIRO and has observed the species level of activity at the recovery site at Cooktown.

It is a very active and vigorous species capable of burying large amounts of fresh dung at a rapid rate.

All of the six sites should be checked for establishment and CLIMEX used to predict the species potential spread of this valuable species.

If adequate funds were obtained a thorough survey of all Queensland species could be carried out. The survey would reveal the following:

- The locations of existing species.
- The locations were beetles numbers were adequate for harvesting.
- “Climex” would indicate by percentage points the match of each species to a new area.
- a description of each species with color photographs detailing the identifying features of a species.
- the results of two surveys carried out each year over two summers (four in all to allow for seasonal variations).

This would provide an adequate assessment of all Queensland species.

The results could be published in a publication, similar to “common Dung Beetles in pastures South Eastern Australia”, M. Tyndale-Biscoe.

Such a publication would enable cattle producers, landcare groups, farmer groups, schools etc. to harvest a particular species for redistribution.

ACKNOWLEDGEMENTS

Landcare Project Manager, Mick Alexander assisted with the hands on survey and presentations to the group of graziers throughout the survey period. I wish to thank Mick and the Taroom Shire Landcare Group for their support and professional attitude towards making this survey a reality, Cheryl Powell for her general assistance throughout the survey and Andrew Coulsell, Dept of Natural Resources, Wandoan for provision of computer resources while on the survey and map layout for this report

APPENDIX 1
PHOTOS

Photo 1 : Dung buried by *O. gazella* and *O. alexis.* The age of the pad was estimated to be less than 24 hours.

Photo 2 : Dung has been scraped aside, revealing some *O. gazella* and *O. alexis* holes. These demonstrate the aeration effect of dung beetles.

APPENDIX 2
SURVEY RESULTS

DUNG BEETLE SURVEY FOR TAROOM LANDCARE AND MLA, QUEENSLAND, JANUARY 1999

SITE	DATE	CO-ORD	LOCATION	STATION IF KNOWN	SPECIES FOUND	ESTIMATE OF AVERAGE BEETLE NO.S PER PAD	EST. AVERAGE BURIAL	SOIL TYPE	FLY LARVAE PER PAD	BUSHFLY NUISANCE
1	7/1/99	S. 28° 29.615 E. 150° 17.498	7.3 km N. Goondiwindi	not known	*O. alexis* *O. gazella*	2 - 3 10 - 60	80 - 90%	black heavy	none	none
2	7/1/99	S. 27° 57.220 E. 150° 20.496	70.6 km N. Goondiwindi	not known	*O. alexis* *O. gazella* *E. intermedius* *O. viridulus*	5 - 10 50 - 100 1 - 3 1 - 2	80%	black soil	none	two
3	7/1/99	S. 27° 40.343 E. 150° 19.904	6.5 km N. Moonie	"Glen Atole Station"	*O. alexis* *O. gazella*	2 - 5 30 - 50	80%	black soil	none	none
4	7/1/99	S. 27° 13.365 E. 150° 10.826	61.2 km N. Moonie	"Willara"	*E. intermedius* *O. gazella* *O. viridulus*	10 - 20 20 - 30 0 - 2	60%	black soil	none	two
5	7/1/99	S. 26° 35.622 E 150°39.159	6 km N. Jackson	not known	*E. intermedius* *O. gazella* *S. spinipes*	15 - 20 5 - 10 5 - 10	60%	rocky shale	none	one
6	7/1/99	S. 26° 23.427 E.149° 35.703	32 km N. Jackson	"Guligimbie" Lyndon Brown's property	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes* *O. viridulus*	2 - 5 10 - 20 20 - 30 2 - 5 0 - 1	80%	black soil	none	none
7	8/1/99	S. 26° 05.367 E. 149° 52.210	10 km W. Wondoan	"Beechley" B. Westman	*O. alexis* *O. gazella* *E. intermedius* *O. viridulus*	1 - 5 10 - 30 10 - 20 0 - 1	80%	black soil	none	none
8	8/1/99	S. 26° 04.972 E. 149° 52.10	17 km W. Wondoan	"Carmody Downs" Pat Devlin	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes*	unable to locate suitable pads	80%	black soil	none	none
9	8/1/99	S. 25° 41.560 E. 149° 49.503	8 km S. Taroom	"Lillyvale"	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes* *O. viridulus*	1 - 2 20 - 70 10 - 20 10 - 100 0 - 1	90%	black soil, some shale	none	one

SITE	DATE	CO-ORD	LOCATION	STATION IF KNOWN	SPECIES FOUND	ESTIMATE OF AVERAGE BEETLE NO.S PER PAD	EST. AVERAGE BURIAL	SOIL TYPE	FLY LARVAE PER PAD	BUSHFLY NUISANCE
10	8/1/99	S. 25° 25.245 E. 150° 18.553	71.7 N. Taroom	"Fairyland"	*O. alexis* *O. gazella* *E. intermedius*	unable to locate suitable pads	n/a	black soil	none	none
11	8/11/99	S. 24° 41.780 E. 150° 08.534		not known	*O. gazella* *E. intermedius* *O. viridulus*	unable to located suitable pads	n/a	black soil	none	none
12	9/1/99	S. 24° 35.191 E. 143° 53.005	16 km S.W.S Moura	"Bears Lagoon"	*O. alexis* *O. gazella* *E. intermedius* *L. militaris* *S. rubrus* *S. spinipes* *O. viridulus*	unable to locate suitable pads	n/a	heavy black soil	none	none
13	9/1/99	S. 24° 38.249 E. 149° 32.876	40 km W. Moura	"Underwood"	*O. alexis* *O. gazella* *E. intermedius* *L. militaris* *S. spinipes* *O. viridulus* *O.quinquituberalatus* (native)	unable to locate suitable pads - farmer collected sample	n/a	black soil	none	two
14	9/1/99	S. 25° 45.658 E. 148° 56.077	not known	"Springwater" Bernie Shelton	*O. alexis* *O. gazella* *E. intermedius* *S. rubrus* *S. spinipes* *O. pugnacior* (native)	n/a n/a n/a n/a 50 - 100	90%	loam	one	one
15	10/1/99	S. 28° 02.122 E. 148° 34.773	1 km N. St. George	not known	*O. alexis* *O. gazella* *E. intermedius*	1 - 5 10- 60 50 - 100	80 - 95%	black soil	none	one
16	10/1/99	S 26° 40.014 E. 148° 58.731	30 km E. Roma	"Cooneroo" Jim West	*O. alexis* *O. gazella* *E. intermedius*	2 8 200 - 300 (Pitt-fall trap collect)	80%	red loam	none	two

SITE	DATE	CO-ORD	LOCATION	STATION IF KNOWN	SPECIES FOUND	ESTIMATE OF AVERAGE BEETLE NO.S PER PAD	EST. AVERAGE BURIAL	SOIL TYPE	FLY LARVAE PER PAD	BUSHFLY NUISANCE
17	11/1/99	S. 25° 52.691 E. 148° 33. 093	89 km N. Roma 6 km S. Injune	not known	*O. gazella* *E. intermedius*	not a good collect, horse dung only	n/a	loam	none	none
18	11/1/99	S. 25° 12.545 E. 148° 35.193	84 km N. Injune	not known	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes*	10 10 - 20 300 - 400 10 - 15 (Pitt-fall trap collect)	80 - 90%	rocky shale	none	four
19	11/1/99	S. 24° 44.892 E. 148° 32.028	139 km N. Injune	not known	*O. gazella* *E. intermedius* *S. spinipes* *O.quinquituberalatus* (native)	30 100 10 (Pitt-fall trap collect)	80%	stoney loam	none	four
20	12/1/99	S. 24° 15.327 E. 148° 16.445	44 km N.W. Rolleston	not known	*O. gazella* *O. wakelbura* (native)	only two pads found in half an hour - not a good site	n/a	black heavey moist soil	none	none
21	12/1/99	S. 23° 36.701 E. 148° 09.616	59 km N. Springsure	not known	*O. gazella* *E. intermedius*	not a good site, unable to find suitable dung. Old pads were buried well	70% old pads 85% plus	red loam	none	one
22	12/1/99	S. 23° 21.549 E. 148° 08.479	17.8 km N. Emerald	not known	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes* *O. viridulus*	unable to find suitable dung	n/a	Rock, shale, light soil	none	none
23	12/1/99	S. 22° 54.695 E. 148° 09.480	4 km E. Peak Downs	not known	*O. gazella*	unable to find suitable dung	n/a	heavey black soil	none	one
24	12/1/99	S. 22° 56.752 E. 148° 07.621	5 km S.W. Peak Downs	not known	*O. alexis* *O. gazella* *E. intermedius* *L. militaris* *S. spinipes* *O. wakelbura* (native)	0 - 1 50 - 100 20 - 40 0 - 5 10 - 40	95%	black soil	none	one

SITE	DATE	CO-ORD	LOCATION	STATION IF KNOWN	SPECIES FOUND	ESTIMATE OF AVERAGE BEETLE NO.S PER PAD	EST. AVERAGE BURIAL	SOIL TYPE	FLY LARVAE PER PAD	BUSHFLY NUISANCE
25	12/1/99	S. 22° 56.452 E148° 04.637	20 km N. Capella	"Peak Downs"	*O. gazella* *E. intermedius* *L. militaris* *S. spinipes* *O. viridulus*	200 - 250 10 - 20 1 - 2 100 - 150 0 - 3	90 - 95%	black soil	none	none
26	13/1/99	S. 23° 26.55 E. 148° 12.221	4.5 km S.E. Emerald	not known	*O. gazella*	unable to find suitable dung, old pads buried well	old pads well buried 90%	black soil	none	one
27	13/1/99	S. 23° 13.189 E. 150° 23.598	27 km N.W. Rockhampton	"Craigoyle" CSIRO site, Belmont	*O. alexis* *O. gazella* *S. spinipes* *O. viridulus* – 8 collected from bared wire fence	unable to find suitable dung	50% ?	black soil	none	none
28	14/1/99	S. 23° 52.905 E. 150° 14.885	4 km N.E. Wowan	"Dundee"	*C. elphanor* *O. gazella* *E. intermedius* *L. militaris* *S. spinipes* *O. viridulus*	farmers collect	n/a	heavy black	Pockets of 100 fly larvae	one
29	14/1/99	S. 24° 050.00 E. 150° 27.00	30 km N.N.W. Biloela	"Greenfields"	*O. alexis* *C. elphanor* *O. gazella* *E. intermedius*	0 - 2 0 -4 5 - 10 30	60%	light loam	50 - 100	two
30	14/1/99	S. 24° 33.374 E. 150° 36. 678	11 km S.E. Thangool	not known	*E. intermedius* *S. spinipes*	unable to find suitable dung	n/a	loam	none	none
31	14/1/99	S. 25° 4.1 E. 151° 45.00	16 km S.S.W. Gayndah	Brian Pastures Research Station	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes*	Not recorded Mick Alexander's collect	Not recorded	Not recorded	n/a	n/a
32	15/1/99	S. 26° 06.691 E.152° 24.621	138 km S.E. Gayndah	"Widgee" Percy Bishop	*O. alexis* *O. gazella* *E. intermedius* *O. sagittarius* *S. spinipes* *O. viridulus*	1 - 3 10 - 30 10 - 30 0 - 5 10 - 20 2 - 3	80 - 90	black soil	none	two

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33	15/1/99	S. 26° 12.196 E. 152° 04.427	2.8 km S. Goomeri	not known	*O. alexis* *O. gazella* *E. intermedius* *S. rubrus* *O. sagittarius* *S. spinipes* *O. viridulus*	1 - 2 10 - 20 10 - 50 2 - 5 30 - 50 2 - 10	85 - 95%	black soil	none	two
34	15/1/99	S. 26° 32.279 E. 152° 00.558	45 km S. Goomeri	not known	*O. alexis* *O. gazella* *E. intermedius* *L. militaris* *S. rubrus*	unable to find suitable dung	85 - 95%	light loam	100 -150	two
35	16/1/99	S. 26° 53.701 E. 152° 16.569	57 km S.E. Nanango	not known	*O. alexis* *O. gazella* *E. intermedius* *L. militaris* *O. sagittarius* *S. spinipes* *O. thoreyi* (native)	insufficient pads found for beetle numbers to be assessed	90 - 95%	Black soil	none	none
36	16/1/99	S. 26° 54.843 E. 152° 19.025	62 km S.E. Nanango	"Glendon"	*O. alexis* *O. gazella* *E. intermedius* *O. militaris* *S. spinipes* *O. viridulus* *O. atrox* (native)	insufficient pads found for beetle numbers to be assessed	85%	loam	none	four
37	16/1/99	S. 27° 13.224 E. 152° 24.696	4 km N. Esk	not known	*O. gazella* *E. intermedius* *L. militaris* *S. rubrus* *S. spinipes* *O. viridulus* *O. atrox* (native) *O. dandalu* (native) *O. thoreyi* (native)	insufficient pads found for beetle numbers to be assessed	90 - 95%	duplex clay, basalt based	none	none

SITE	DATE	CO-ORD	LOCATION	STATION IF KNOWN	SPECIES FOUND	ESTIMATE OF AVERAGE BEETLE NO.S PER PAD	EST. AVERAGE BURIAL	SOIL TYPE	FLY LARVAE PER PAD	BUSHFLY NUISANCE
38	16/1/99	S. 26° 58.669 E. 152° 21.938	2 km E. Harland	"Mahronghi" Keith Moore	*O. gazella* *E. intermedius* *L. militaris* *H. nomas* *S. spinipes*	not assessed	not assessed	red loam	none	none
39	16/1/99	S. 27° 02.086 E. 151° 48.591	40 km N. Crows Nest	not known	*O. alexis* *O. binodis* *O. gazella* *E. intermedius* *S. rubrus* *S. spinipes*	not assessed	80%	grey duplex clay	none	none
40	17/1/99	S. 27° 08.415 E. 151° 57.377	20 km N. Crows Nest	not known	*O. alexis* *O. binodis* *O. gazella* *E. intermedius* *H. nomas* *O. viridulus*	insufficient pads found for beetle numbers to be assessed	90 - 95%	river loam	none	none
41	17/1/99	S. 27° 25.924 E. 151° 55.597	38 km S.W. Crows Nest	not known	*E. africanus* *O. alexis* *O. binodis* *O. gazella* *E. intermedius* *O. nigriventris* *O. pecuarius* *S. spinipes* *O. viridulus* *O. australis* (native)	0 - 1 2 - 5 0 - 2 20 - 40 10 - 20 0 - 1 0 - 1 0 - 1	90 %	black soil	none	two
42	17/1/99	S. 27° 25.895 E. 151° 47.092	approx. 50 km S.W. Crows Nest	not known	*E. africanus* *O. alexis* *O. gazella* *E. intermedius* *S. rubrus* *S. spinipes* *O. viridulus*	0 - 1 2 - 8 20 - 50 20 - 50 0 - 1 0 - 1 0 - 1	80 - 90%	red loam	none	10 – 20 Note: only 36 bushflies were seen until this stop

SITE	DATE	CO-ORD	LOCATION	STATION IF KNOWN	SPECIES FOUND	EST. OF AVERAGE BEETLE NO.S PER PAD	EST. AVERAGE BURIAL	SOIL TYPE	FLY LARVAE PER PAD	BUSHFLY NUISANCE
43	17/1/99	S. 27° 28.780 E. 151° 44.785	approx. 70 km S. W. Crows Nest	not known	*O. alexis* *O. gazella* *E. intermedius* *S. spinipes* *O. viridulus*	5 - 10 20 - 40 10 - 20 n/a n/a	90%	red, rocky loam	none	10 – 20 per person
44	17/1/99	S. 27° 28.117 E. 151° 59.010	approx 15 km E.N.E. Toowomba	"Spring Bluff"	*O. alexis* *O. binodis* *O. gazella* *E. intermedius* *L. militaris* *O. nigriventris* *H. nomas* *O. pecuarius* *S. spinipes*	0 - 2 0 - 2 30 - 40 20 - 40 0 - 4 0 - 2 0 - 4 10 - 100 0 - 1	90 - 95%	black soil	none	none
45	18/1/99	S. 27° 17.041 E. 151°3 4.934	65 km N.W. Toowoomba	"Cunningham Park" Mick Alexander's property	*O. alexis* *O. gazella* *E. intermedius* *S. rubrus* *S. spinipes* *O. viridulus* *O. australis* (native)	0 - 1 20 - 50 0 - 30 0 - 20 0 - 1 0 - 1	70 - 95%	heavy black soil	50 - 100	10 - 20
46	18/1/99	S. 26° 35.668 E. 150° 25.622	34 km W. N. W. Chinchillla	"Wongabintta"	*O. alexis* *O. gazella* *E. intermedius* *S. rubrus* *S. spinipes* *O. viridulus*	0 - 2 20 - 40 30 - 40 0 - 5 0 - 5 0 - 1			none	none
47	19/1/99	S. 28° 08.755 E. 150° 17.896	59 km S. Miles	Presentation at Billa Billa Hall	*O. alexis* *O. gazella* *E. intermedius*	insufficient pads found		black soil	none	none