APPENDIX 4: A survey and risk analysis of the insect fauna of Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve

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A4.1 Summary

The islands of Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve were surveyed for insects during June 2002 as part of an environmental risk assessment of the Reserves. The results of this and previous surveys are discussed particularly from an ecological and conservation perspective. Relatively few species were observed compared to a previous visit, and this may be due to the lateness of the season as well as the abundance of Asian house gecko on at least West Island.

A4.2 Introduction

Ashmore Reef National Nature Reserve is located 850 km W of Darwin, and contains three permanently emergent islands: East (12°15.74'S, 123°05.68'E), Middle (12°16.02'S, 123°01.88'E) and West (12°14.49'S, 122°57.88'E) Islands. Thirty six species of terrestrial plants have been record at various times on these islands (Pike and Leach 1997). Of the three islands, West Island is the most accessible.

Cartier Island Marine Reserve is located approximately 46 km south east of Ashmore Reef, and has a single emergent sand cay (12°31.85'S, 123°33.31'E). This cay is unvegetated and contains little driftwood or flotsam. It is used extensively as a turtle nesting site. There appears to be no previous record of insects having been collected on Cartier Island.

Insect collecting in Ashmore Reef National Nature Reserve has been sporadic in the past, with the most comprehensive collecting having been undertaken by: Des Pike, a former warden of the reserves, during several trips in March, April and May 1992; myself during 8-18 May 1995; and Tony Postle, Northern Australian Quarantine Strategy, Broome, during 22-25 February 2000. Only two reports (Pike 1992, Brown 1999) on the fauna have been written, with the material listed by Pike re-examined and incorporated in the report by Brown. A list of records of insects and other arthropods was also made available by Tony Postle (pers. comm.).

Brown (1999) listed 127 species of insects in 67 families as well as 7 families of spiders, and one each of pseudoscorpions (order Pseudoscorpionida), centipedes (order Scolopendrida) and millipedes (order Polyxenida). The material collected by Pike (1992) was re-examined by Brown incorporated into his report (Brown 1999).

Postle (pers. comm.) listed 48 species of insects in 39 families as well as a slater (order Isopoda), a tick and a mite (order Acarina), a springtail (order Collembola), and an unknown number of spiders (order Araneida) from his survey in February 2000. Most of these, apart from the ants, moths and butterflies, were only identified to family level.

It should be noted that these previous collections, together with the present trip, have been short, sporadic and often not undertaken at the best times of the year to give either a true list of the resident fauna or a true picture of the ecological dynamics of the fauna from season to season, or year to year.

This report lists the insects collected during 11-20th June 2002 and discusses the results in relation to previously recorded species. Particular emphasis is given to ecological and other environmental issues that are relevant to the management of these Reserves.

A4.3 Methods

Ashmore Reef was visited from 11-20th June 2002 aboard the Australian Customs Vessel *Holdfast Bay*, and in the company of Ian Cowie, Botanist, Northern Territory Herbarium. The trip also included a visit to Cartier Island on 14 June. Collecting was primarily by hand or with a butterfly net, and included searching in sand, leaf litter, under rocks and logs, on plants, and by sweeping vegetation. In addition, a Malaise trap (Fig. 1) was set up on West Island at 12°14.6'S, 122°58.2'E.

Figure 1: Malaise trap, West I.

It was not possible to use additional Malaise traps on East and Middle Islands due to concerns about their effect on nesting birds, and the likelihood that they would be quickly destroyed by perching birds (especially since there appears to be a severe shortage of roosting sites on these islands). Similarly, light trapping was planned for West Island, but this was not undertaken due to the small number of insects present as well as operational issues that resulted from the ACV being moored at the outer anchorage. Yellow pan traps which are effective in collecting small ground dwelling species, were not considered for use on this trip as they were ineffective and only collected large numbers of hermit crabs when I last visited to Ashmore in May 1995. They however, may have been effective as very few hermit crabs were seen. Bird parasites were not assessed as this requires specialised bird handling techniques.

Most collecting was undertaken on West Island as there were virtually no nesting birds that would be disturbed by a human presence. East and Middle Islands were only visited briefly because of the large numbers of nesting birds on the islands, and the impossibility of doing detailed surveys without stressing or harming the birds.

Specific searches were made as follows:

- for a general insect biodiversity survey
- of the current distribution of ginger ant, *Solenopsis geminata* (Fabricius)
- for ants, especially the crazy ant, *Anoplolepis gracilipes* (Smith)
- for wood boring beetles, especially the families Cerambycidae and Bostrichidae
- for termites, especially drywood termites of the genus *Cryptotermes*
- for the presence of terrestrial molluscs including Giant African Snail, *Achatina fulica* Bowdich, and *Parlogenia* sp.
- of the current distribution of Asian house gecko, *Hemidactylus frenatus* Duméril and Bibron
- for the presence of other terrestrial reptiles
- for the presence of rodents
- for the presence of any other organism that would affect the ecology of insects and vice versa
- of the public access area of West Island
- of all fresh water sources
- of the ACV *Holdfast Bay* and other boats visiting the Reserves

- for organisms of environmental risk to Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve
- for organisms of quarantine risk to Australia
- of Cartier Island Marine Reserve.

These searches, particularly those for specific organisms or in specific sites, were perceived to be of special interest for a risk analysis of Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve.

A4.4 Results

The survey was too late in the season to sample the full diversity of Ashmore's insect fauna. Conditions on the three Ashmore islands were very dry, and with the exception of a small number of species, most insects were rare, and collecting poor.

Forty eight species including 42 insects and six other terrestrial arthropods were observed or collected at Ashmore Reef National Nature Reserve. These are listed in Table 2. The unidentified dusty-wings lacewing (family Coniopterygidae) and thrips (family Thripidae) are the only new records for Ashmore Reef National Nature Reserve. Conversely there were no dragonflies (order Odonata), mantids (order Mantodea), butterflies (order Lepidoptera) or psocids (order Psocoptera) found, and relatively few species of leafhoppers and true bugs (order Hemiptera), flies (order Diptera), moths (order Lepidoptera), and wasps (order Hymenoptera).

The higher taxa found are summarised in Table 1, together with those collected by Pike in March, April and May 1992, Brown in May 1995 (Brown 1999) and Postle in February 2000 (Tony Postle pers. comm.).

On West Island the only common species were the moths *Utethesia* sp(p). (family Arctiidae), *Anisodes ?obrinaria* (Guenée) (family Geometridae) and the unknown pterophorid (family Pterophoridae), the grasshoppers *?Aiolopus* sp. and *Pycnostictus seriatus* Saussure (family Acrididae) and an unknown blattellid cockroach (family Blattellidae). The *Utethesia* moths were associated with octopus bush, *Argusia argentea argentea.* The larvae of these had caused minor damage to most leaves, but only one live larva was found. One moth in good condition was also found on *Argusia argentea* on East Island, but there was no larval damage observed on any of the leaves. No evidence of *Utethesia* was found on Middle Island.

The geometrid and pterophorid moths are probably associated with creepers, *Ipomoea* spp., and Tar Vines, *Boerhavia* spp., respectively, and the blattellid cockroaches with *Argusia argentea*. All three insects were only found on West Island, whilst the grasshoppers were common on all three islands, although their distribution may have been more patchy on East and Middle Islands. The latter were associated with grasses including *Digitaria mariannensis*.

Apart from grasshoppers, bushflies *Musca vetustissima* (Walker) (family Muscidae) (Fig. 2) and small black flies, *Siphunculina striolata* (Wiedemann) (family Chloropidae) (Fig. 3) were also common on both East and Middle Islands.

Figure 2: Bushfly on predated egg, East I.

Figure 3: Chloropid flies on *Argusia* flowers

Two species of jumping spider (family Salticidae) were also relatively common on West Island, and present on all three islands. The blue salticid was only found on shrubs, while the brown species occurred on both shrubs and on the ground. The latter could be confused with a juvenile wolf spider (family Lycosidae) as they are similarly coloured.

The Malaise trap confirmed the abundance of the geometrid and arctiid moths, and the cockroaches. It also detected the presence of several other smaller insects that were not otherwise observed.

Table 1: Numbers of families and insects collected during past and present surveys

	Pike: March-May 1992		Brown: May 1995		Postle: February 2000		Brown: June 2002	
TAXA	**Family**	**Species**	**Family**	**Species**	**Family**	**Species**	**Family**	**Species**
non-insects								
ISOPODA					1	1	1	1
DIPLOPODA	1	1					1	1
SCOLOPENDRIDA	1	1					1	1
PSEUDOSCORPIONIDA	1	1						
ACARINA					2	2		
ARANEIDA	6	7	5+	5+	1+	1+	2+	3+
COLLEMBOLA					1	1		
insects								
THYSANURA					1	1	1	1
ODONATA	2	2	3	5				
BLATTODEA	1	2	1	3	1	1	1	1
MANTODEA	1	1						
ORTHOPTERA	3	6	3	6	3	6	3	6
EMBIOPTERA	1	1	1	1	1	1	1	1
PSOCOPTERA					1	1	1	1
PHTHIRAPTERA					1	3		
HEMIPTERA	4	6	6	11	7	9	4	4
THYSANOPTERA							1	1
NEUROPTERA	1	1	1	1	1	1	2	2
COLEOPTERA	9	10	7	7	3	3	5	6
DIPTERA	11	13	10	14	14	14	7	8
LEPIDOPTERA	10	31	11	28	3	3	5+	5+
HYMENOPTERA	5	5	9	11	2	4	8	9
Total insects	49	78	51	87	39	48	40+	46+
Total all species	57	88	57+	92+	44+	53+	45+	46+
New insect records	49	78	36	49	16	20	2	2

The Ginger ant, *Solenopsis geminata* (Fabricius) (family Formicidae) (Fig. 4), was present and widespread on all three islands including the beaches. It was found under most dead birds, but usually in relatively small numbers. However, much larger numbers were observed near the pump on West Island and under the coconut trees on Middle Island (Fig. 5), where more water could have been available. *Paratrechina longicornis* (Latrielle) was the only other ant found. It occurred on and under larger shrubs and trees.

Figure 4: Ginger ant nest, East I.

Figure 5: Overturned coconut, Middle I.

Figure 6: Driftwood, Middle I.

Searches for specific insect pests found no evidence of boring beetles or termites in living or dead trees, or in driftwood (Fig. 6).

No terrestrial snails or slugs were found.

The Asian house gecko was common on West island. It was found on all larger pieces of wood above the high water mark with several often being seen on each log. It was also heard calling in the coconut trees. It was not observed in any of the *Argusia argentea* bushes, although it is expected to occur there. It was not found on East or Middle Islands, although similar conditions occurred there. No other terrestrial reptiles were found.

There was no evidence of rats on West Island, although an egg (Fig. 2) found on East Island showed possible damage from an unknown vertebrate predator.

Three individual raptors were present and actively feeding on West Island. At least two of these were Nankeen Kestrels, *Falco cenchroides*, and appeared to be preying on grasshoppers on the ground, as the prey was small and not visible to the naked eye.

Amphipods were common under wetter driftwood on beach, and there were very few hermit crabs compared to a previous visit in May 1995.

No insects that differed from those found elsewhere were found in the public access area (although ginger ant was abundant at one site as mentioned above). This included water

associated with the pump on West Island, and the wells on West and Middle Island. These wells were closed and inaccessible to both humans and insects, and it is therefore presumed that no insects were breeding in any of these wells.

There was little insect life found on ACV *Holdfast Bay* and these are listed in Table 3. All were found prior to or within two days of arriving at Ashmore. An extensive search of the boat found no other insects.

The only boat present at Ashmore Reef on arrival was another customs boat moored at the outer mooring 5.2 km from the nearest land (West Island). This boat departed after two hours following the transfer of equipment to the ACV *Holdfast Bay*, which used the same anchorage. There were no other boats present until two days prior to our departure when a yacht from Darwin arrived. Crew from the yacht boarded the ACV *Holdfast Bay* and vice versa. Domestic cockroaches were said to be common on the yacht, although none were observed. About ten Indonesian fishing vessels arrived the following day, some of which anchored near the ACV *Holdfast Bay*, and others closer to West Island.

On Cartier Island insects and mites were generally rare and difficult to find (Table 4). Only two species of insect were observed: a redlegged ham beetle, *Necrobia rufipes* (De Geer) (family Cleridae) on the carapace of a dead turtle, and a small midge (family Chironomidae) running ant-like on the sand. Several mites were also observed under a dead and dehydrated tern. Hermit crabs were also common in and around the dead turtles, and in a hollow log.

A4.5 Discussion

Biodiversity

Ecosystems are always dynamic, and this is particularly so in small, isolated and relatively simple environments such as those found on Ashmore Reef. To survive and establish, new introductions have many requirements including food, water and shelter. If any one of these is absent, scarce or disappears, or if significant predators or parasites are present, the species may be unable to survive.

A total of 149 species in 103 families of insects has been recorded from Ashmore Reef National Nature Reserve (Table 1) at various times between 1992 and 2002 by Pike (1992), Brown (1999) and Postle (pers. comm.). However, some of these may not be permanently established, as they have not been recollected during subsequent surveys. The results of these surveys are summarised as follows:

Pike 1992

Pike recorded 49 families of insect representing 78 species. Of these at least 11 families have not been recollected (Brown 1999, Postle pers. comm.), and comprise a dragonfly (family Aeshnidae), mantids (family Mantidae), beetles (families Carabidae, Scarabaeidae and an unknown family), flies (families Drosophilidae and an unknown family) moths (families or superfamilies Gelechoidea, Oecophoridae and Tineidae) and Hymenoptera (families Evaniidae). However, there is a possibility that some of the unidentifiable moths collected in the present survey may belong to some of these species.

Brown 1995

Brown (1999) increased the list to 85 families and 127 species of insect (including two species of water strider (family Gerridae) recorded in the literature prior to 1992). Of these the beetle family Anthribidae, the fly family Agromyzidae and the butterfly family Pieridae have not been recorded previously or subsequently.

Postle 2000

Postle increased the list to 101 families and 147 species of insect, although nearly all were only identified to family level. Most of these were either flies (families Calliphoridae, Chironomidae, Dolichopodidae, Pipunculidae and Lauxaniidae) or bugs (families or superfamilies Coccoidea, Coreidae, Dictyopharidae, Plataspidae and Pseudococcidae). Other new records were for

psocids (family Ectopsocidae), the wasp families Eulophidae, Eurytomidae and Sphecidae, and silverfish (family Lepismatidae). The last two families were also collected during the present survey. Only one species of moth, *Utethesia pulchelloides* (family Arctiidae) was collected by Postle (pers. comm.).

Brown 2002

As Postle (pers. comm.) only identified most species to family level, it is not possible to calculate how many new records were found during this survey. The only confirmed additional records are for a dusty-wings lacewing (family Coniopterygidae) and a thrips (family Thripidae). The latter, although yet to be identified, may be of concern to Ashmore or especially Australia, as many species in this family are serious plant pests. The lack of other new records is a reflection of the time of year that the survey was undertaken.

Despite these figures, there is insufficient baseline data on the insect fauna of Ashmore Reef (or Cartier Island) to make many general comments on the species found during this (or previous) surveys. The most noticeable difference between my previous trip in May 1995 however, was that there were very few insects found: 87 in 1995, 46+ in 2002), and of these only three species of moth (*Utethesia* sp(p), *Anisodes ?obrinaria* and the unidentified pterophorid), two grasshoppers (?*Aiolopus* sp. and *Pycnostictus seriatus*), and an unknown blattellid cockroach were conspicuously abundant. This may have been due to the later timing of this trip and a poorer wet season. However, the presence of the Asian House Gecko in numbers on West Island as discussed below, must be having a significant effect.

Ginger ant

Ginger ant, *Solenopsis geminata* (family Formicidae), is an introduced fire ant. It is a native to North America and has spread throughout much of the tropics including Indonesia and the Top End of the Northern Territory. It is most likely to have been introduced from Indonesia. It is a small aggressive ant that lives in large subterranean colonies, and attacks in large numbers. It feeds on insects and other animals including vertebrates. Sick, vulnerable or tethered animals are particularly susceptible to attack. This ant is an extremely dangerous threat particularly to ground nesting birds, and its impact may already be significant as it has been recorded on Middle and West Islands since at least 1992. It is likely that it will hinder and deter nesting birds, and attack and kill hatching young and older surviving hatchlings.

It is now widespread on all three islands at Ashmore Reef, and is surviving on dead birds. It may be more abundant in the wet season and could be having an effect on nesting birds and turtles, but neither of these issues could be determined during this visit. These should be followed up, as well as consideration of its eradication.

Other ants

The only other ant found was the hairy ant, *Paratrechina longicornis*. This species is widespread throughout the tropics including Australia and was only found on the *Argusia argentea* and on fish plate shrub, *Guettarda speciosa*. However, Postle (pers. comm.) also tentatively recorded *Tetramorium* sp. and a second species of *Solenopsis*.

Crazy ant, *Anoplolepis gracilipes* is also a potential threat to Ashmore Reef National Nature Reserve. This ant causes similar problems to ginger ant, although it does not sting. It is widespread in Indonesia including Timor, and has been intercepted in quarantine in Darwin on a number of occasions. It rapidly moves into new nesting sites such as bags and boxes, and as such could be easily transported to Ashmore Reef. The islands should be monitored for this and other introduced ants at regular intervals.

Borers and termites

The introduction of any insects that will destroy the bird nesting sites will have serious effect on these birds. This applies particularly to boring beetles and termites. None have been found to date, however some species of both groups may remain undetected in wood for many years before their presence is known. Of particular concern are drywood termites, *Cryptotermes* spp. These occur in many Indonesian fishing vessels, and can live in relatively small pieces of timber

for many years before they are noticed. Fishing vessels including boat wrecks and large pieces of driftwood are possible sources of introduction.

Terrestrial molluscs

No terrestrial molluscs (and very few hermit crabs) were found. Of particular concern is the giant African Snail, *Achatina fulica*, which is widespread in Indonesia, including Timor. It occurs in many habitats including vegetated sandy soil at the beach margin similar to that found on Ashmore. It is capable of aestivating during the dry season. It could survive on Ashmore and by its presence have a devastating effect on the vegetation and the ecology, including the recruitment of such plants as *Argusia argentea*.

This snail and others such as *Parglogenia* (family Camaenidae) are regularly intercepted in quarantine in Darwin on shipping containers from Timor. Although there is a risk of introduction by Type II foreign fishing vessels, there is a much higher risk if other people such as illegal immigrants or equipment arrives on the islands.

Asian house gecko

The Asian House gecko, *Hemidactylus frenatus* was rare in May 1995. It was neither seen nor heard at that time, and its presence was only detected in a Malaise trap on West Island. It is now widespread and abundant on West Island, but not detected on either East or Middle Islands.

This species is easily spread through the activities of man, and it is most likely that this species arrived by boat from Indonesia. It is an insect feeder, and eats large numbers of insects. The presence of this species has the potential to reduce the abundance and diversity of insects, and to reduce the chances of newly introduced (both naturally and by man) species becoming established. It must be having a significant effect on the invertebrate fauna and this may be indicated by the small numbers of insects seen as well as the presence of very few abundant species. A study on the stomach contents of these lizards could determine the diversity of their prey. The present abundance of this lizard on West Island probably precludes its eradication.

Other terrestrial vertebrates

No evidence (animals, tracks or scats) of other terrestrial reptiles apart from Asian House Gecko or rodents was found. However, one noddy (or tern) egg found on East Island (Fig. 2) showed evidence of predation. Damage is similar to that caused by birds such as silver gulls or crows. However, these birds are not present on Ashmore, and discussions with Dr Helen Larson, Museum and Art Gallery of the Northern Territory, and Ray Chatto, Parks and Wildlife Commission of the Northern Territory could not resolve this issue. The hole appears to be too small for a chick to have hatched from the egg.

Other organisms

The presence of raptors may be reducing the size of the grasshopper populations on West Island. If so, this could result in rapid and long term changes in the abundance and biomass of some plants such as grasses on West Island. However, this is an expected part of the ecology of Ashmore Reef, and the raptors should not be removed.

Public access area

No difference in the insect fauna was found between the public access area on West Island and the remainder of the island. The risks to this area are more likely to be botanical rather than entomological, although the landing of equipment here and elsewhere increases the chances of introducing insects such as exotic cockroaches, plant seeds and other organisms such as reptiles and molluscs. The more equipment that is landed, the bigger the risk.

Freshwater sources

Apart from the potential physical danger of well holes to both humans and animals, these, and the pump site on West Island, could possibly provide a source of water for mosquito larvae. The issue of mosquitoes is further discussed below under Quarantine.

As currently found, these sites do not present a physical danger, or provide a source for mosquitoes to breed in.

ACV 'Holdfast Bay' and other boats

The presence of black field cricket, *Teleogryllus oceanicus* (Le Guillou), on the ACV *Holdfast Bay* as well on the *Aurelia IV* anchored in the inner lagoon in May 1995 (Brown 1999) demonstrates that insects are transportable to the islands. This species was considered to have become established after May 1995 (Brown 1999, Des Pike pers. comm.). The presence of a large nymph on West Island (Table 2) supports this. The large size of this cricket precludes it having been blown there.

Similarly the presence of the arctiid moths, *Amata* sp., on board the ACV *Holdfast Bay* as well as HMAS *Wollongong* in May 1995 (Brown 1999) also indicates how easily insects (Table 3) may be transported to Ashmore Reef. The presence of the noctuid moth on the second night of anchoring may also indicate this, although noctuids are capable of flying long distances well beyond the 5.2 km to West Island, and readily fly to lights. As the ACV *Holdfast Bay* was the only visible light from the islands at that time, it is not possible to determine if the moth originally came from the boat or the islands. There were no other insects found on the *Holdfast Bay* despite an extensive search. This was at least partially due to the cleanliness and the cold operating temperature in most parts of the boat.

The presence of cosmopolitan hide beetles, *Dermestes ater* De Geer (Brown 1999) and *Dermestes lardarius* Linneaus on Ashmore Reef and redlegged ham beetle, *Necrobia rufipes* (De Geer) on Cartier Island are likely to have come from an Indonesian fishing vessel as both feed on a variety of dried meats including dried fish.

Environmental risks to Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve

Ecosystems are always dynamic, and this is particularly so in small, isolated and relatively simple environments such as Ashmore Reef. To survive and establish, new introductions have many requirements including food, water and shelter. If any one of these is absent or disappears, the species cannot survive. However, the question arises as to how far this natural process should be monitored and manipulated in the management of the park. The presence of any particular plant or animal is going to have an effect on the survival of other organisms, and this is going to affect others. As a result, the establishment of any single species may effect the direction of ecological succession permanently, or for a very long time (for example the Nankeen Kestrels feeding on grasshoppers may result in significantly larger biomasses of grasses and herbs in following years). This warrants a good management policy for the monitoring and control of new introductions. Control of pests and weeds is not sufficient, as these terms are artificial. Similarly, the term "natural species" as used and defined in the Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve Management Plans (Commonwealth of Australia 2002) is meaningless in relation to insects as all would have been introduced at some point in time. These issues need to be addressed in the management strategies of Section 6 of the Management Plans.

Apart from those organisms discussed above, there were no other species found during this or previous surveys that are likely to pose an environmental risk to Ashmore Reef National Nature Reserve or Cartier Island Marine Reserve. The continued presence by an Australian Customs vessel at Ashmore Reef will minimise the risk of unnatural and accidental introductions by humans.

Quarantine risks to Australia

Several of the above issues illustrate the importance of quarantine for the islands. The threat of accidentally introducing insects and other organisms from Australia, from Indonesia and from elsewhere is a real one. This is particularly important if illegal immigrants continue to land there.

Because of this, there is also an increased quarantine risk to Australia, from both insects and other animals, as well as from the diseases they may carry or transmit. The increased number

of people from more diverse parts of the world landing on the islands increases the risk of introducing exotic insects and diseases. It also increases the risk of these being spread from these people to Australian residents and thus the Australian mainland. One clearly identifiable risk is the possibility of mosquito larvae breeding in drinking water and bilge water on Indonesian fishing boats. Adult mosquitoes transmit diseases such as dengue fever and malaria by biting an infected person and then biting an uninfected person. Mosquitoes biting Indonesian fishermen or illegal immigrants and then an Australian resident could easily spread the disease to Australia. Of particular concern is dengue fever, which is spread by the dengue mosquito, *Aedes aegypti* (Linnaeus) (family Culicidae). Neither this disease nor the vector mosquito is established in the Northern Territory, although both could become established there.

Cartier Island Marine Reserve

The insect fauna is small and its role in the ecology of Cartier Island appears to be very small and simple. The redlegged ham beetle and mites would compete to a very minor extent with hermit crabs while the midge may be native as the larvae of some species are associated with organic matter in semi-marine environments. There is unlikely to be any environmental or management issues with the insect fauna of Cartier Island Marine Reserve.

A4.6 Recommendations

1. Regular surveys of terrestrial invertebrates to gain an understanding of the dynamics of the populations and the detection of potentially harmful introductions both to the ecology of the islands, and as potential quarantine risks to Australia.
2. Determine the effect on bird and turtle nesting sites of the Ginger ant, *Solenopsis geminata*, and consider its eradication.
3. Compile a target list of undesirable and potentially harmful exotic organisms including borers, termites, ants and terrestrial snails that are likely to be easily introduced by humans and that may have a significant effect on the island's ecology.
4. Establishment of management guidelines for the detection and eradication of undesirable plants and animals (including a definition of "undesirable" and "native", particularly in relation to insects).
5. Study the effect of Asian House Gecko on the insect fauna.
6. Determine the extent of dying bushes on East and Middle Islands and, if replacement by humans is considered warranted, what effect any additional bushes will have on the current ecosystem.
7. Limit access to all three islands by both people and equipment to reduce the risk of introducing exotic plants and animals.
8. Procedures to be implemented to minimise the introduction of exotic organisms including diseases into Australia via Ashmore Reef National Nature Reserve.
9. Determine guidelines for how far humans should interfere with the natural succession of organisms on Ashmore Reef.
10. Maintain a permanent presence at Ashmore Reef to do all the above.

A4.7 Acknowledgments

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A4.8 References

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TABLE 2: Insects and related terrestrial arthropods found on Ashmore Reef (tentative or unconfirmed identifications are marked with "?", and all records are for adults unless otherwise indicated)

CLASS INSECTA
ORDER THYSANURA (silverfish)
Lepismatidae
unknown sp. A
under hollow immature coconut beneath coconut trees, Middle Island.

ORDER BLATTODEA (cockroaches)
Blattellidae
unknown sp. A
common on *Argusia argentea* and in Malaise trap, West Island.

ORDER ORTHOPTERA (crickets, katydids and grasshoppers)
Acrididae
?Aiolopus sp.
adults and nymphs on grass, East, Middle and West Islands.
Pycnostictus seriatus
adults *and* nymphs on grass, East, Middle and West Islands.
Gryllidae
Teleogryllus oceanicus (Le Guillou)
large nymph on grass, West Island.
Trigonidopomorpha/*Methioche* sp.
nymphs and adults on *Argusia argentea* and in Malaise trap, West Island.
Tettigoniidae
Conocephalus sp.
nymph in Malaise trap, West Island.
unknown sp. A
nymphs of various sizes on *Argusia argentea*, West Island.

ORDER EMBIOPTERA (webspinners)
Oligotomidae
?*Aposthonia* sp.
under hollow immature coconut beneath coconut trees, Middle Island.

ORDER HEMIPTERA (leafhoppers, planthoppers, true bugs)
Cicadellidae
Orosius argentatus (Evans)
in Malaise trap, West Island.
Delphacidae
unknown sp. A
in Malaise trap, West Island.
Lygaeidae
Geocoris sp.
on grass, West Island.
Nabidae
unknown sp. A
in Malaise trap, and common on grass, West Island.

ORDER THYSANOPTERA (thrips)
Thripidae
unknown sp. A
Middle Island.

ORDER NEUROPTERA (lacewings)
Coniopterygidae
unknown sp. A
in Malaise trap, West Island.
Chrysopidae
Chrysopa ramburi Schneider
on *Argusia argentea* and in Malaise trap, West Island.

ORDER COLEOPTERA (beetles, weevils)
Anthicidae
?*Anthicus* sp.
on sand in bird rookery, East Island.
Coccinellidae
Coccinella transversalis Fabricius
on grass between *Argusia argentea* bushes, West Island.
Dermestidae
Dermestes ater De Geer
on dead turtle, West Island.
Dermestes lardarius Linnaeus
larva on sand in bird rookery, Middle Island.
Elateridae
near *Conoderus* sp.
in Malaise trap, West Island.
Tenebrionidae
Gonocephalum sp.
under coconut fallen from coconut tree on Middle Island, and in large numbers under one (only) rock on West Island.

ORDER DIPTERA (flies, midges, mosquitoes)
Chloropidae
Siphunculina striolata (Wiedemann)
common on ground, and *Argusia argentea* and *Tribulus cistoides* flowers, East and Middle Islands.
Ephydridae
Hecamede complex
near fringing vegetation, East Island.
Muscidae
Musca ?vetutissima Walker
on ground and damaged eggs, East and Middle Islands.
Sarcophagidae
unknown sp. A
on vegetation, West Island.
Stratiomyidae
unknown sp. A
in Malaise trap, West Island.
Tachinidae
unknown sp. A
on sticks, grasses, shrubs on West Island.
unknown sp. B
on fringing grass, East Island.
Ulidiidae (= Otitidae)
Acrosticta sp.
in Malaise trap, West Island.

ORDER LEPIDOPTERA (moths and butterflies)

Arctiidae

Utethesia sp(p).

common around *Argusia argentea* bushes and in Malaise trap, West Island; many leaves had minor leaf damage, but only one larvae found, West Island; one moth on *Argusia argentea* but no larvae or leaf damage, East Island.

Geometridae

Anisodes ?obrinaria (Guenée)

common on *Ipomoea violacea* and in Malaise trap, West Island.

Noctuidae

Earis smaragdina Butler

on *Argusia argentea*, West Island.

Pterophoridae

unknown sp. A

common on tar vine, *Boerhavia* sp. and in Malaise trap, West Island.

Unknown Lepidoptera

several damaged specimens

in Malaise trap, West Island.

ORDER HYMENOPTERA (ants, bees and wasps)

Bethylidae

unknown sp. A

in Malaise trap, West Island; on *Tribulus cistoides* flowers, East Island.

Braconidae

Cotesia sp.

in Malaise trap, West Island.

Encyrtidae

unknown sp. A

in Malaise trap, West Island.

Formicidae

Paratrechina longicornis (Latrielle)

on shrubs especially fish plate shrub, *Guettarda speciosa*, West Island.

Solenopsis geminata (Fabricius)

common, widespread and found under most dead birds on East, Middle and West Islands, highest numbers observed near pump on West Island and under coconut trees on Middle Island.

Ichneumonidae

?*Pristomeris* sp.

in Malaise trap, West Island.

Pompilidae

Anoplius opulentus Smith

single specimens seen, East, Middle and West Islands.

Scelionidae

Scelio sp.

in Malaise trap, West Island.

Sphecidae

Sphex (Sphex) sp.

in Malaise trap, West Island.

NON-INSECTS

ISOPODA (slaters)

unknown sp. A

under hollow immature coconut beneath coconut trees on Middle Island.

ARACHNIDA – ARANEIDA (spiders)
Salticidae
unknown sp. A (blue markings)
on shrubs, East, Middle and West Islands.
unknown sp. B (brown body)
on ground and plants, East, Middle and West Islands.
Unknown Araneida
in Malaise trap, West Island.

DIPLOPODA (millipedes)
unknown sp. A
in leaf litter at edge of concrete slab, West Island.

CHILOPODA (centipedes)
Scolopendromorpha
unknown sp. A
in leaf litter, West Island.

TABLE 3: Insects found on ACV *Holdfast Bay* (prior to arriving at and whilst on station at outer mooring 5.2 km from West Island, Ashmore Reef)

ORDER ORTHOPTERA (crickets, katydids and grasshoppers)
Gryllidae

Teleogryllus oceanicus (Le Guillou)

one dead prior to arriving and one live on deck at time of first arriving at outer mooring.

ORDER LEPIDOPTERA (moths and butterflies)
Arctiidae

Amata sp.

on deck at night under light on day of arrival.

Noctuidae

unknown sp. A

flew away from light on deck at night the day after arriving.

TABLE 4: Insects and mites found on Cartier Island

ORDER COLEOPTERA (beetles and weevils)
Cleridae
Necrobia rufipes (De Geer)
on dead turtle

ORDER DIPTERA (flies, midges, mosquitoes)
Chironomidae
unknown sp. A
running ant-like on sand above high-tide mark

ORDER ACARINA (ticks and mites)
unknown Acarina
unknown sp. A
several under a dead tern

APPENDIX 5: Protocols for hull inspections and collection of samples of suspected non-indigenous marine species at Ashmore Reef

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The following protocols for hull inspections and collection of samples of non-indigenous marine species at Ashmore Reef are based on methodologies adopted for hull inspections of suspect vessels for the Port of Darwin. The protocols outlined here are suitable for ACV personnel undertaking inspections using basic snorkel gear.

1. Ensure with the Master of the vessel that the motor is not operating and notify them of the intention to dive the submerged portions of the vessel.
2. When in the water scrutinise the fouling community near the air/water interface in addition to the general hull surface.
3. Pay careful attention to fouling accumulating in creviced areas and where antifoulant has been scraped away including:
    - rudder,
    - propeller and shaft,
    - under side of the keel,
    - pipe outlets
    - spacing between planks on wooden vessels.
4. In the event that significant fouling is evident on the vessel samples need to be collected.
5. If possible take a photograph of the area prior to removal of the sample.
6. When collecting the biofouling from the vessel endeavour to remove the organisms in their entirety without damaging them.
7. Immediately after collection place the samples on ice until they can be preserved in alcohol. A supply of alcohol preservative (70% ethanol) and plastic containers suitable for preservation of marine samples can be obtained from the Museum and Art Gallery of the Northern Territory (contact number 08 8998201).
8. Record on a label to be included with the sample the:
    - date, time and method of collection,
    - the vessel details (name port of origin, state of antifoulant if any),
    - location on vessel from which the sample was collected,
    - details of the photograph if taken (ie frame number from film).
9. Preserved samples need to be returned to Darwin for collection by NT Fisheries Group Aquatic Pest Management (contact number 0413 991 643), who will forward specimens to the Museum and Art Gallery of the Northern Territory for identification. Any subsequent taxonomic work required may need to be paid for by DEH.

In the event that an exotic species is collected from a vessel NT Fisheries Group Aquatic Pest Management will notify both the National Consultative Committee on Introduced Marine Pest Emergencies (CCMPE) and the Marine Park Division of the Australian Government Department of Environment and Heritage for the implementation of the appropriate response plan.