



Australian Government

Department of the Environment and Energy

Department Risk Analysis

Application to add *Euonthophagus crocatus*, *Onthophagus marginalis* spp. *andalusicus* and *Gymnopleurus sturmi* (three species of dung beetle) to the Environment Protection and Biodiversity Conservation Act 1999 *List of Specimens taken to be Suitable for Live Import*

November 2019

INTRODUCTION

Purpose of the proposed import

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) seeks to import three beetle species from the Scarabaeinae subfamily, *Euonthophagus crocatus*, *Onthophagus marginalis spp.andalusicus* and *Gymnopleurus sturmi* into Australia as part of the large Rural Research and Development for Profit program 'Dung Beetles as Ecosystem Engineers'. The Scarabaeinae subfamily is known commonly as the 'true dung beetles'.

There are over 7000 species of dung beetle worldwide. Dung beetles have preferences based on vegetative cover, dung type, soil type, flight times (diurnal, twilight or nocturnal), climate and season (Doubé and Marshall, 2014).

The purpose of introducing *E. crocatus*, *O. m. andalusicus* and *G. sturmi* is to fill the current seasonal and geographic gaps in dung beetle activity in southern Australia. The three dung beetle species will be bred to large numbers (8 000+) then released into the environment at targeted sites to enhance dung dispersal and burial and to limit bush fly larvae survival in major sheep, beef and milk producing areas of southern Australia.

Adult *E. crocatus*, *O. m. andalusicus* and *G. sturmi* will be collected from several localities in south-western Europe and northern Africa and air-freighted to Australia (up to 500 pairs per consignment). The beetles will be held in an Approved Arrangement site (quarantine) in Canberra. Their eggs will be treated with disinfecting agent (Virkon®), removed from quarantine, reared to adulthood and released at targeted sites and/or used for the establishment of mass-rearing colonies, the progeny of which will be released. Release numbers will vary according to the numbers reared, but at any given site, the aim will be to release a minimum of 500 male-female pairs of each species.

Background

Under s303EC of the *Environment Protection and Biodiversity Conservation Act 1999* (the Act), the responsible Minister may amend the *List of Specimens taken to be suitable for live import* (Live Import List) by including a specimen in the list. There are two parts to the List:

- Part 1 comprises specimens that can be imported without a permit under the Act and
- Part 2 comprises specimens that require a permit under the Act to be imported. Import restrictions generally apply to the species listed in Part 2, such as 'Eligible non-commercial purpose only, excluding household pets'. Additional conditions may also be applied when the permit for import is issued.

Before amending the Live Import List, the Minister must consult with appropriate Ministers and other persons, and consider a report assessing the potential environmental impacts of the proposed amendment. When submitting an application to the Department to amend the Live Import List, all applicants are required to provide an accompanying report that addresses specific terms of reference.

The Department undertakes a risk assessment using the information in the applicant's report and any other relevant information. The Department also considers comments and information received through the public consultation process (including states and territories). The application and accompanying draft report for the proposed import of three species of dung beetles (*E. crocatus*, *O. m. andalusicus*, and *G. sturmi*) was released for public comment between 8 February and 5 April 2019.

BIOLOGY AND ECOLOGY

Introduction

E. crocatus, *O. m. andalusicus*, and *G. sturmi* are all members of the *Scarabaeinae* subfamily and are known commonly as dung beetles. No common names for *E. crocatus*, *O. m. andalusicus* and *G. sturmi* are found in the literature.

The applicant has stated that "*Onthophagus andalusicus* was reclassified to a subspecies of *Onthophagus marginalis* by some (Boucher 1990). *Onthophagus marginalis marginalis* has an Asian distribution, while *O. marginalis andalusicus* has a more western distribution with four morphotypes 1/ Himalayan region, which may coexist with *O. marginalis marginalis* (Jean-Pierre Lumaret personal communication), 2/ eastern Mediterranean and central Asian regions, 3/ Italian, and 4/ Iberian peninsula and Northern Africa, which is the region targeted in this application (Martin-Piera and Lopez-Colon 2001)".

E. crocatus and *O. m. andalusicus* have stable populations in Morocco but have been found also in Algeria, Tunisia and Libya with unconfirmed sightings in southern Italy and southern Spain (Ruiz, *et al.* 2015). *G. sturmi* is widely distributed throughout the Mediterranean Basin and has stable populations in northern Africa but appears in declining numbers in Western Europe (Spain Portugal, France and Italy) (Lumeret, *et al.* 2015).

Description

All three species have an expected lifespan of at least one year. CSIRO will confirm their longevity during the rearing process. Their physical characteristics are described at length in the application. *E. crocatus* and *G. sturmi* are both black in colour whilst *O. m. andalusicus* has yellow elytra (wing case) with irregular black marks (see below).

All three species are similar in size:

1. *Euonthophagus crocatus* adults are 6-12mm long (Baraud, 1992 cited by applicant), with a dry (dead specimen) weight of 22.1 mg (Errouissi *et al.* 2004).
2. *Onthophagus marginalis* spp. *andalusicus* adults are 6-12mm long (Baraud, 1992 cited by applicant), with a dry weight of 31.7 mg (Errouissi *et al.* 2004).
3. *Gymnopleurus sturmi* adults are 10-15mm long (Baraud, 1992 cited by applicant), with a dry weight of 85 mg (Errouissi *et al.* 2004).



Image 1: Left: Male *Euonthophagus crocatus* (from Ballerio *et al.* 2014). Middle: Male *Onthophagus marginalis* spp. *andalusicus* (Ballerio, 2010 from Ballerio, *et al.* 2014). Right: *Gymnopleurus sturmi* of unknown sex (Ballerio, 2010 from Ballerio, *et al.* 2014).

Life cycle

E. crocatus and *O. m. andalusicus* nest in soil beneath dung pats – tunneling directly into the soil beneath the pat to create deep chambers which they fill with dung and into which they lay their eggs. *G. sturmi* rolls dung into a ball to remove it from the dung pat. When it finds a suitable place, it will excavate under the ball to sink it into the soil. It will then lay its eggs into the ball.

When hatched the larvae feed on dung solids eating their way through the ball and along the tunnels whilst growing into adults. This can take anything from six weeks to several years depending on the species and conditions. Newly emerged adults walk or fly in search of fresh dung on which to feed and mature whilst excavating shallow tunnels in which they feed on the juices of buried dung for several weeks.

Once mature, beetles will bury their dung deeper than immature feeding beetles and lay eggs while continuing to feed on dung juices. The adults will continue to create brood balls and tunnels in which to lay their eggs until the dung pat is all gone. They will then walk or fly to the next dung pat (Doube and Marshall, 2014).

While they are not migratory *E. crocatus*, *O. m. andalusicus* and *G. sturmi* may disperse to find the resources they need to survive – dung pats. The dispersal rates for the three species is currently unknown however dung beetles previously introduced into Australia and North America *Digitonthophagus gazella*, *Onthophagus taurus* and *Euonticellus intermedius* were recorded to spread up to 100 km a year from the location of their introduction. Not all dung beetles disperse such distances; *Copris hispanus* has dispersed only 20 km from its release location in Western Australia in 20 years (Doube and Marshall, 2014).

Many species of dung beetle require a period of diapause at some time in their life cycle (Hanski and Cambefort, 1991). Although unrecorded in their home range it is expected that *E. crocatus*, *G. sturmi* and *O. m. andalusicus* will all require a period of diapause or overwintering prior to emerging to breed but more study is needed to be certain.

Some species of dung beetle are known to have up to three generations per year. *E. crocatus*, *G. sturmi* and *O. m. andalusicus* have an expected lifespan of at least one year. CSIRO will confirm their longevity during the rearing process.

In their natural geographic range *E. crocatus*, *G. sturmi* and *O. m. andalusicus* are predated on by owls, buzzards, larks, badgers and small rodents (Young, 2015).

In Australia dung beetles are predated on by magpies, ibis, ravens, kookaburras, foxes and bats (Doube and Marshall, 2014).

Diet

Adult dung beetles do not have the mouthpieces to eat solid or dried dung and live on the juices of moist dung. The dung juices provide nutrition in the form of microorganisms native to the mammalian gut such as yeast, bacteria, fungi and protozoa (Doube and Marshall, 2014). Adults lay their eggs in brood balls made of solid dung on which the larvae then feed.

E. crocatus prefers cattle and sheep dung but will also eat horse and goat dung or human faeces (Janati-Idrissi, 2000, Romero-Samper, 2008, Chamorro, 2013 - cited by applicant).

O. m. andalusicus prefers cattle and sheep dung (Errouissi et al. 2004, Errouissi, et al. 2009).

G. sturmi prefers sheep dung but will eat cattle and horse dung and human and dog faeces (Errouissi, et al. 2004, Lumaret, et al. 2015).

As the three species only consume dung, they will not feed on agricultural or native plants or animals.

Dung beetles are not social but will be found in large groups when feeding on a dung pat (Doube and Marshall, 2014). Breeding pairs of some species co-operate during nesting (Halffter and Edmonds, 1982) but it is unknown if pairs from the three species work together.

Climate

All three species of dung beetle are native to the Mediterranean basin (south-western Europe and northern Africa). All three are found in areas with an arid climate of cool, wet winters and hot dry summers (Houston, 1982).

As outlined by the proponent "*Euonthophagus crocatus* prefers open habitats and humid pastures but is sometimes found in forested areas (Labidi, et al. 2017). *Gymnopleurus sturmi* prefers open, dry sites, including grasslands, shrublands, sandy beaches, and agricultural sites (Sanchez piñero pers. obs. 2014 cited in Lumaret, et al. 2015), with clay or sandy soil (Sanchez piñero pers. obs. 2014 cited in Lumaret, et al. 2015). *Onthophagus marginalis* spp. *andalusicus* prefers wetter habitats in dry, hot areas of the Mediterranean, such as lagoons, salt marshes, coastal areas, and humid pastures (Dewhurst 1979 and 1980 cited in Verdú, et al. 2015, Labidi, et al. 2017).

Distribution and endemism (as regards conservation status)

Range Description:

E. crocatus and *O. m. andalusicus* are found in Morocco, Algeria, Tunisia and Libya with unconfirmed sightings in southern Italy and southern Spain (Ruiz, et al. 2015). *G. sturmi* is widely distributed throughout the Mediterranean Basin and has stable populations in northern Africa but appears in declining numbers in Western Europe (Spain, Portugal, France and Italy) (Lumeret, et al. 2015).

Reason for import

In southern Australia, there are no native or introduced dung beetles that are actively using dung in the late winter and early spring. The Bush Fly (*Musca vetustissima*) breeds in the warmer north of Australia then migrates south with the recurring warm north-north-west winds associated with anticyclones in later winter and early spring (Hughes 1970). The absence of active dung beetles allows the Bush Fly to breed and disperse to southern parts of Australia where they live until late autumn when the weather becomes too cold and they die out (Hughes 1970). The activities of dung beetles are expected to reduce the breeding success of the Bush Fly by consuming and dispersing the livestock dung in which the Bush Fly lays its eggs.

CSIRO has successfully released 23 species of dung beetles into Australia to manage and disperse dung from agricultural livestock for which there are no native dung beetles. Each of these species fills a niche based on their preferences including vegetative cover, dung type, soil type, flight times (diurnal, twilight or nocturnal), climate and season (Doubé and Marshall, 2014). CSIRO now seeks to import a further three dung beetle species, *E. crocatus*, *O. m. andalusicus* and *G. sturmi*, into Australia as part of the large Rural Research and Development for Profit program 'Dung Beetles as Ecosystem Engineers' to fill the current seasonal and geographic gaps in dung beetle activity in southern Australia.

E. crocatus, *G. sturmi* and *O. m. andalusicus* have been assessed by CSIRO as active in late-winter to early-spring.

It is predicted that the three species will enhance dung dispersal and burial and limit Bush Fly larvae survival in major sheep, beef and milk producing areas of southern Australia.

Importation of the three dung beetle species would also be subject to an importation approval by the Commonwealth Department of Agriculture.

Disease transmission

The applicant describes a process for starving and cleaning the collected beetles prior to shipping and keeping the imported adults in an Approved Arrangements (Quarantine) facility for the duration of the project. Only the eggs will be allowed out of the quarantine facility.

By burying and dispersing dung and through digestion dung beetles have been found to destroy pathogens including *Cryptosporidium parvum* and *Escherichia coli*, both of which pose a risk to humans (Mathison and Ditrach, 1999, Ryan, *et al.* 2011, Jones, *et al.* 2015), and livestock intestinal worms such as those in the *Trichostrongylus* family (Doubé and Marshall, 2014).

Ball rolling may disperse pathogens onto the soil (Xu, *et al.* 2003) however, ball rolling dung beetles do not roll their dung balls far from the dung pat so the pathogens would remain in the pasture from which they originated.

Any pathogens that survive the intestinal tract of dung beetles or attach to their bodies have the potential to be passed on to people. The Centre for Disease Control and

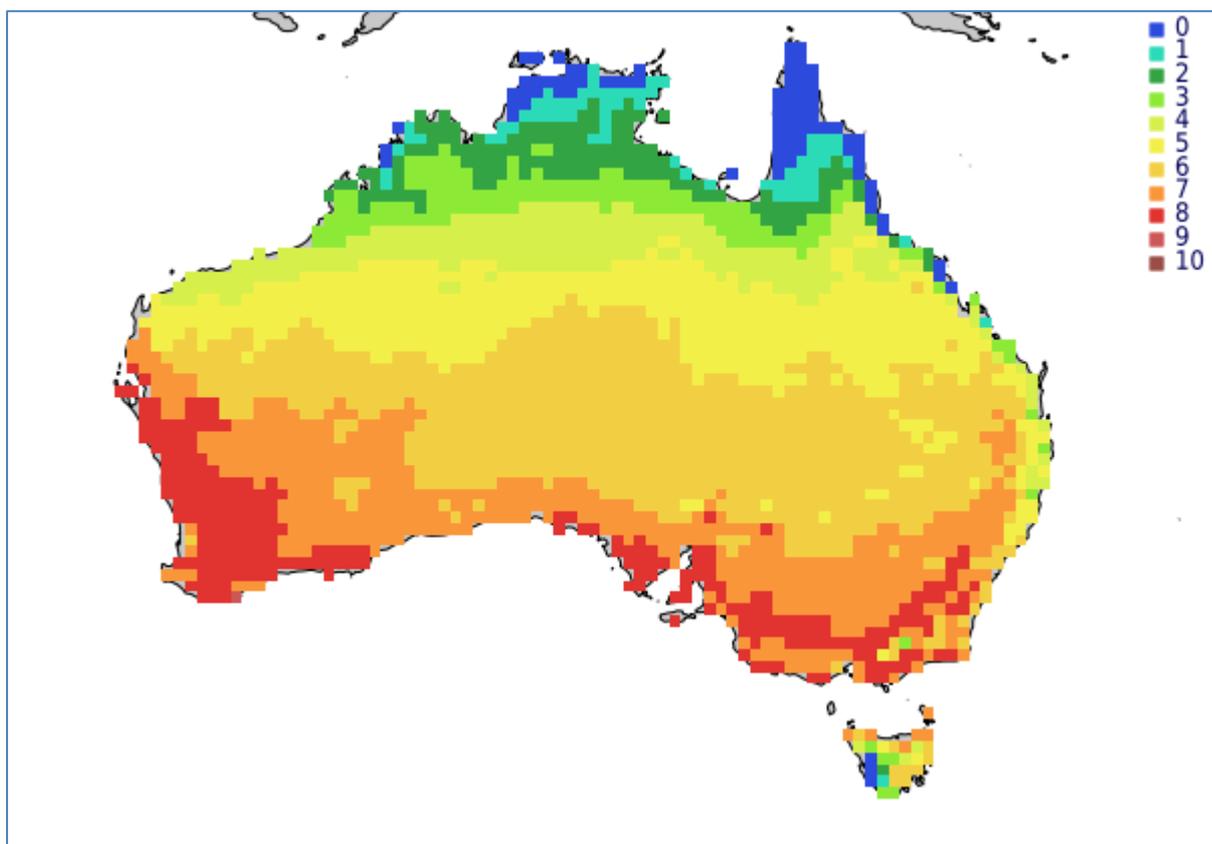
Prevention (2009) recommends that people should take precautions and not handle dung, dung beetles or pasture soil.

Establishment

The establishment of *E. crocatus*, *G. sturmi* and *O. m. andalusicus* in Australia is the purpose of this application.

The species are well matched to the southern Australian environment based on the Climatch output shown below (Climatch). There are no reported instances of any of the three species establishing and becoming a nuisance in any other country.

Map 1: Climatch potential suitable habitat for *E. crocatus*, *G. sturmi* and *O. m. andalusicus* based on current range



The applicants report shows the predicted range of each species.

Related Live Import List listings

Three species of dung beetle are listed in Part 1 of the Live Import List - *Bubas bubalus*, *Copris hispanus* and *Onthophagus vacca*. This allows live specimens to be imported without requiring a permit.

Two species of dung beetle are listed in Part 2 of the Live Import List - *Bubas bison* and *Onitis belial* – both requiring a permit with the conditions ‘Eligible non-commercial purpose only, excluding household pets. High security facilities only’.

Conservation status

None of the three species is listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) checklist.

1. *Euonthophagus crocatus* is listed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species as of Least Concern as it has stable populations in Morocco (Ruiz, *et al.* 2015).
2. *Onthophagus marginalis* spp. *andalusicus* is listed on the IUCN Red List of Threatened Species as of Least Concern due to its wide distribution (Verdú, *et al.* 2015).
3. *Gymnopleurus sturmi* is listed as Near Threatened on the IUCN Red List under criteria B2. *G. sturmi* has a small area of occupancy, continuing decline in habitat and number of mature individuals, and fragmentation of its subpopulations in Europe. It remains abundant in northern Africa (Lumaret, *et al.* 2015).

RISK ASSESSMENT

Assessing the risk of the potential of introducing a new organism into the environment involves assessing the risk of it becoming established and spreading and the likely impacts if establishment occurs.

There are no accepted risk assessment models that can be used to calculate the establishment risk of invertebrates in Australia. Bomford (2008) found that for vertebrates, the level of risk can be assumed in accordance with the four key factors of establishment success. These factors are:

- Propagule pressure – the release of large numbers of animals at different times and places enhances the chance of successful establishment
- Climate match – introduction to an area with a climate that closely matches that of the species' original range
- History of establishment elsewhere – previous successful establishment
- Taxonomic group – belonging to a family or genus which has a high establishment success rate.

Although these factors apply to vertebrates, they have been used as a guide for this risk assessment of *E. crocatus*, *O. m. andalusicus* and *G. sturmi*. In addition, using the information compiled from research into the above factors for *E. crocatus*, *O. m. andalusicus* and *G. sturmi* the potential impacts of establishment of feral populations can also be assumed.

LIKELIHOOD OF ESTABLISHMENT

The application for the listing of *E. crocatus*, *G. sturmi* and *O. m. andalusicus* is to allow the import and release of the dung beetles for the control of cattle and sheep dung. All imports would be subject to an import permit from the Department of Agriculture that would direct that any live *E. crocatus*, *G. sturmi* and *O. m. andalusicus* imported into Australia go into an Approved Arrangement (quarantine) site.

The likelihood of escape of live imported specimens from the Approved Arrangement (quarantine) site in Canberra is negligible. Quarantine facilities are required to have security measures in place to ensure that the movement of specimens in and out of the facility is tightly controlled and these measures should negate any chance of the specimens escaping.

If listed, and the CSIRO research deems them suitable, the three species would be bred to increase their numbers and released in areas that are climatically and environmentally suited to them. It is the applicant's goal to establish viable populations of the dung beetles that will spread and establish in the region.

Climate match – introduction to an area with a climate that closely matches that of the species' original range

The native range of *E. crocatus*, *G. sturmi* and *O. m. andalusicus* in the Mediterranean region is limited to arid landscapes at low elevations. The Climatch map shows most of southern Australia is climatically suited to the three dung beetle species. The beetles were selected based on their high level of climate matching to fill a void in the current extent of introduced dung beetle communities.

History of establishment elsewhere – previous successful establishment

The specificity of the individual species of dung beetle indicates that they will only establish in locations where the conditions meet their requirements for vegetative cover, dung type, and soil type, climate and season. There have been instances where introduced dung beetles have dispersed and established in areas beyond their expected range (Montes de Oca and Halffter, 1998, Mesquita Filho, *et al.* 2018) disrupting the composition and diversity of resident dung beetle species. This is not expected in Australia as the introduced species are agricultural livestock dependent - that is cow, sheep, goat and horse, while the endemic species are adapted to marsupial dung in forest or woodland habitats (Doube, *et al.* 1991).

Taxonomic group – belonging to a family or genus which has a high establishment success rate

Dung beetles have a long and extensive history of human assisted establishment worldwide in areas outside their native range as a tool to manage ruminant dung. In Australia, 45 species of dung beetles have been introduced, of which 23 have established populations to date (Doube, 2018).

The *Scarabaeidae* family has only one member regarded as highly invasive – *Oryctes rhinoceros* or Asiatic rhinoceros beetle – a plant eater (GISD, 2019).

The sub family *Scarabaeinae*, or the true dung beetles, have no members regarded as invasive (GISD, 2019).

E. crocatus and *O. m. andalusicus* are both members of the Onthophagini tribe; six members of the Onthophagus genus are established already in Australia. There are no members of the Gymnopleurini genus, of which *G. sturmi* is a member, established in Australia (Doube, 2018).

Potential impacts of established feral populations

E. crocatus, *G. sturmi* and *O. m. andalusicus* are not recorded as having established populations outside their natural range. Mesquita Filho (2018) has recorded that one species of dung beetle (*Digitonthophagus gazella*), introduced into livestock pastures in Brazil, is outcompeting native dung beetles that inhabit a similar niche. This is unlikely to occur in Australia as the native dung beetles occupy very different niches.

The purpose of introducing the dung beetle species *E. crocatus*, *O. m. andalusicus* and *G. sturmi* is to deliberately establish wild populations in order to carry out dung management activities and reduce the occurrence of the Bush Fly. All three species are likely to establish populations in Australia as they have been specifically chosen for the purpose of reducing the impact of agricultural livestock dung on the Australian environment. Doube (2018) states that cattle in Australia produce more than 250 million tonnes of dung per year – enough to cover over 200,000 hectares of pasture. Through rapidly burying dung the beetles will be beneficial to the Australian environment by reducing the area of dung smothered pasture, increasing carbon input into the soil and recycling plant nutrients as well as reducing the populations of the Bush Fly.

The Department of Agriculture would undertake a full assessment of the potential disease risks of the three dung beetles under the *Biosecurity Act 2015* if the species are listed.

In-coming beetles will be held in an Approved Arrangement (quarantine) site in Canberra. Their eggs will be treated with disinfecting agent (Virkon®), removed from quarantine, reared to adulthood and released into the wild and/or used for the establishment of mass-rearing colonies, the progeny of which will be released. Only sexually mature beetles which have been physiologically synchronised to the local season will be introduced.

Risk summary and mitigation measures

The CSIRO has a 50-year history of introducing dung beetles into the Australian environment. Forty-three species of dung beetle have been released since the 1960s. Of the 23 species that have established no species is considered a threat to the environment or agriculture.

Comments on the proposal to import *E. crocatus*, *O. m. andalusicus* and *G. sturmi*

The Department undertook consultation with relevant ministers (or their delegates), government agencies and the public in February – April 2019. The Department received five comments/questions – and the responses are in *italics*:

- 1) The ACT government was supportive of the application.
- 2) The SA government was supportive of the application but sought further details on how climate change may impact predicted establishment of the species.

Additional information on climate change has been included in section 7.3 of the updated application. It is expected that climate change may alter the distribution of many if not all dung beetle species in Australia. As the climate changes it is expected that the beetles will follow their niche as it changes spatially. Further establishment may be an advantage for dung control in other areas. If livestock dung isn't available the beetles will die out.

- 3) The Victorian government was supportive of the application but requested clarification of the taxonomy of *Onthophagus andalusicus* and requested that both morphological and molecular diagnostics of the three species be undertaken.

*The applicant has updated section 1 of the application to discuss the taxonomic reclassification of *Onthophagus andalusicus* to *Onthophagus marginalis* spp. *andalusicus*. The applicant has advised that the three species, *E. crocatus*, *G. sturmi* and *O. m. andalusicus*, have been 'barcoded' in France to clarify any taxonomic questions and provide a baseline for any evolutionary changes that may occur as a result of their establishment in Australia.*

- 4) Two non-government organisations requested further information:

- a) On the need to clarify the taxonomy of *Onthophagus andalusicus*, including subspecies, and any biogeographical variations.

See 3 above.

- b) Information on the quarantine procedures for cleaning the imported adult beetles.

Diseases and consequences for agriculture, livestock, and other exposure groups will be assessed as part of the Department of Agriculture's Biosecurity Import Risk Assessment process.

- 5) A discussion on factors that have reduced the effectiveness of some previous dung beetle introductions and how these have been addressed in this project.

Additional information has been included in section 6 of the updated application discussing the reasons for both success and failure of previous introductions.

The Department is satisfied that all questions have been adequately addressed by the applicant.

No further comments were received in relation to this application.

GovTEAMs consultation round

The Department undertook consultation on the draft Risk Analysis report with relevant government agencies from 21 October to 8 November 2019. The Department's request for comments included a statement that if no comments were received by the due date the Department will assume support for the draft report and recommendations.

The ACT and South Australia responded supporting listing of the species. Victoria remained uncomfortable about the taxonomy of *Onthophagus andalusicus*, as raised in the first round of comments, but were supportive of the application on the condition that the taxonomy of *Onthophagus andalusicus* is clarified. No other responses were received.

The Department is satisfied that the CSIRO has clarified the taxonomy of *Onthophagus marginalis* spp. *andalusicus* (see point 3 above).

CONCLUSION

The Department has undertaken a risk analysis and reviewed the available information on *Euonthophagus crocatus*, *Gymnopleurus sturmi* and *Onthophagus marginalis* spp. *andalusicus* with regards to including these species in the Live Import List.

The Department concludes that the release of the three dung beetles poses negligible risk to the Australian environment. Accordingly, the Department recommends that these species be added to Part 1 of the Live Import List.

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