Heteronychus arator

Scientific Name
Heteronychus arator (Fabricius)

Synonyms:
Heteronychus arator australis Endrödi,
Heteronychus indenticulatus Endrodi,
Heteronychus madagassus Endrodi,
Heteronychus sanctaehelenae Blanchard,
Heteronychus transvaalensis Peringuey,
Scarabaeus arator Fabricius

Figure 1. Illustration of each stage of the life cycle of the black maize beetle, showing a close up view of each stage and a background view showing that the eggs, larvae, and pupae are all underground stages with the adults being the only stage appearing above ground. Illustration courtesy of NSW Agriculture. http://www.ricecrc.org/Hort/ascu/zecl/zeck113.htm

Common Name(s)
Black maize beetle, African black beetle, black lawn beetle, black beetle

Type of Pest
Beetle

Taxonomic Position
Class: Insecta, **Order:** Coleoptera, **Family:** Scarabaeidae

Reason for Inclusion
CAPS Target: AHP Prioritized Pest List-2006 – 2009

Pest Description
Life stages are shown in Figures 1 and 2.

<u>Eggs:</u> White, oval, and measuring approximately 1.8 mm (approx. $^{1}/_{16}$ in) long at time of oviposition. Eggs grow larger through development and become more round in shape. Eggs are laid singly at a soil depth of 1 to 5 cm (approx. $^{3}/_{8}$ to 2 in). Females each lay between 12 to 20 eggs total. In the field, eggs hatch after approximately 20 days. Larvae can be seen clearly with the naked eye (CABI, 2007; Matthiessen and Learmoth, 2005).

<u>Larvae:</u> There are three larval instars. Larvae are creamy-white except for the brown head capsule and hind segments, which appear dark where the contents of the gut show through the body wall. The head capsule is smooth textured, measuring 1.5 mm (approx. $^{1}/_{16}$ in), 2.4 mm (approx $^{1}/_{8}$ in), and 4.0 mm (approx. $^{3}/_{16}$ in) at each respective instar. The third instar is approximately 25 mm (1 in) long when fully developed. Black maize beetle larvae are soil-dwelling and resemble white 'curl grubs.' They have three pairs of legs on the thorax, a

prominent brown head with black jaws, and are up to 25 mm (1 in) long. The abdomen is swollen, baggy, and gray/blue-green due to the food and soil they have eaten. Larvae eat plant roots, potentially causing significant damage to turf, horticultural crops, and ornamentals. Turf is the preferred host of the larvae (CABI, 2007; Matthiessen and Learmoth, 2005).

Figure 2. Eggs, larvae, and adult African black beetle. Photo courtesy of Yates Ltd. http://www.yates.com/au/ProblemSolver/BlackBeetle.asp

Pupae: The larvae, when fully grown, enter a short-lived pupal stage, which measures approximately 15 mm (approx. $^{9}/_{16}$ in) long and is typically coleopteran in form (cylindrical shape), initially pale yellow, but becoming reddish-brown nearer to the time of emergence (Matthiessen and Learmoth, 2005).

Adults: Adults are 12 to 15 mm (approx. $^{1}/_{2}$ to $^{9}/_{16}$ in) long; shiny black dorsally and reddish-brown ventrally. The females are slightly larger than males. Males and females are readily differentiated by the shape of the foreleg tarsus. The tarsus of the male is much thicker, shorter, and somewhat hooked compared with that of the female, which is longer and filamentous. A less obvious sexual difference is in the form of the pygidium at the end of the abdomen. In the male, it is broadly rounded, and in the female, it is apically pointed. The adult is the main pest stage (CABI, 2007; Matthiessen and Learmoth, 2005).

Biology and Ecology

Heteronychus arator is a polyphagous, univoltine pest of pasturelands, turf, and agricultural crops in Australia, New Zealand, and Africa. These scarab beetles spend their entire lifecycle belowground, with the exception of the adult stage (Matthiessen and Learmonth, 1998) (Fig. 1). In spring, the majority of mating occurs, although some may ensue in fall. During this time, adults crawl on the soil surface at night, and flying is limited. Larvae mature in midsummer. Adults emerge after about two weeks in summer to late autumn. The adults are usually found on or under the soil surface, to a depth of about 15 cm (approx. 5 $^{15}/_{16}$ in). They are a shiny black and cylindrical cockchafer, approximately 15 mm (approx. $^{9}/_{16}$ in) long. The adult is capable of flying, which serves to disperse the beetle to new sites (Matthiessen and Learmoth, 2005). This insect is particularly noted for its massed swarms that occur at high population levels (Watson, 1980). The beetles are nocturnal. Wet conditions during the egg and first instar larval stages are fatal, but as the larvae grow, their ability to cope with high moisture levels increases (Matthiessen and Learmoth, 2005).

Figures 3 and 4. Lateral and dorsal views of *Heteronychus arator* adult (Pest and Diseases Image Library).

In Australia, development from the egg stage to adult emergence takes about three months. Temperatures above 15°C (59°F) are most favorable for development and survival of *H. arator*, with optimum larval development occurring at 20 to 25°C (68 to 77°F) (King et al., 1981a).

Damage

The adult is considered the main pest stage attacking a wide variety of plants. However, larvae can cause damage to turf and underground crops, notably potato tubers (Matthiessen and Learmoth, 2005).

<u>Corn:</u> In corn, the beetles chew into the stems of the growing plants just below the soil surface, causing rapid wilt of the growing center leaves (‘deadheart’) and death of the plant. The damaged area of the stem has a frayed (shredded) appearance, which distinguishes it from the damage caused by cutworms. The fraying is caused by the beetles consuming the soft tissues but leaving the

fibrous material. Both young and mature plants may be attacked, but damage usually occurs in the early stages of growth up to 7 weeks after planting. The peak period is 3 to 5 weeks after planting. If young plants are infested, however, a reduction in plant stand is often observed. Replanting is the only solution for plant stand reduction. Older plants are weakened and prone to lodging. Beetles may attack the ears of lodged plants. The grubs (larvae) prefer to feed on organic matter in the soil but may cause some root damage. Corn plants are often stunted and have multiple tillers. Toit et al. (1997) indicated that natural grass habitats may be preferred for oviposition and that adults migrate from natural vegetation to corn for feeding.

<u>Grape:</u> Damage typically involves chewing of the cortex of stems just below the surface of the ground, ringbarking (or girdling) of the vines, and wilting and collapse of vines. The first occurs most frequently, causes greater growth distortion, and is potentially fatal to newly planted cuttings or seedlings. The whole plant may be toppled or uprooted. The chewing is more likely to be sufficiently deep or to extend more fully around the circumference of the thinner stems at early stages of plant growth. The problem is greatest where vines have been planted onto old pasture land, especially if kikuyu (*Pennisetum clandestinum*) is present (known to occur in California, Hawaii, Puerto Rico, and USVI (USDA-NRCS, 2014).

<u>Potato:</u> In potato, the beetles burrow into the tubers and make holes approximately 10 mm (approx. $^{3}/_{8}$ in) in diameter with frayed edges. The depth of the holes varies depending on the length of time the beetles feed on the tubers. They can be as large as holes made by millipedes (Venter and Louw, 1978). At times, the larvae can feed in the cavities made by the adults.

<u>Small grains:</u> Damage can occur in pastures, particularly newly-sown ryegrass and perennial grasses, millet, corn, turf, barley, triticale, and wheat crops (not oats) (Matthiessen and Learmoth, 2005). High densities of *H. arator* in pastures lead to clover (a non-host) becoming dominant over grasses (King et al., 1982; Matthiessen and Learmoth, 2005).

<u>Sugarcane:</u> In sugarcane, damage is similar to that in corn but results in ‘dead hearts’ in young cane or attack of the underground buds and stem bases in older cane.

Pest Importance

The adult is the main pest stage. The adult is the only aboveground stage and is capable of flight. The beetles are of considerable economic importance because they attack a wide range of plants. The beetle damages pastures, a wide range of vegetable crops, grape vines, ornamental plants, and newly planted trees. Larvae damage turf and underground crops, notably potato tubers (Matthiessen and Learmoth, 2005). According to Drinkwater (1979, 1982), *H. arator* is a soil insect of great importance on maize in South Africa.

Grape: The impact on newly planted grapevine and eucalyptus seedlings can be severe in patches within a vineyard or plantation, leading to areas of total loss amongst the plant stand. Heavy damage to perennial pasture can be caused by *H. arator* build-up in years with a drier than average spring and early summer, causing greater than usual survival of first instar larvae (King et al., 1981b). These climate-driven outbreaks are characteristic of regions that typically have a wet summer, such as the North Island of New Zealand and eastern Australia. Across the regions infested by black maize beetle, this insect can cause significant economic damage to horticultural crops such as young vines (newly planted cuttings and young, rooted vines), olives, and potatoes.

In grape, damage primarily occurs in the first two years after planting because after this time the vines become too woody to be damaged by the beetle. However, older vines may still be damaged, especially if they have been stressed. The impact of losing young vines is twofold, including replanting costs (especially if grafted vines are involved), and loss of yield through delayed grape production. The unevenness in vine maturity in the block presents management problems, for example, in terms of weed control and vine training. Partial damage to vines by *H. arator* can result in retarded growth and add to the cost of vine training because of the prolonged time that such vines require individual attention (Matthiessen and Learmoth, 2005; CABI, 2007).

Known Hosts

Major hosts

Cynodon dactylon (Bermuda grass), *Dactylis glomerata* (cocksfoot grass), *Digitaria sanguinalis* (hairy crab grass), *Echinochloa crus-galli* (barnyard grass), *Echinochloa frumentacea* (Japanese barnyard millet), *Eucalyptus* spp. (Eucalyptus tree), *Eragrostis tef* (tef lovegrass), *Festuca arundinacea* (tall fescue), *Hordeum vulgare* (barley), *Lolium* spp. (ryegrass), *Lolium* x *hybridum* (hybrid ryegrass), *Lolium perenne* (perennial ryegrass), *Lolium rigidum* (annual ryegrass), *Paspalum dilatatum* (dallisgrass), *Solanum tuberosum* (potato), *Vitis vinifera* (grape), and *Zea mays* (corn) (King and Watson, 1982; CABI, 2007; Maddison and Crosby, 2009).

Minor hosts

Ananas comosus (pineapple), *Begonia* spp. (begonia), *Brassica napus* (turnip), *Brassica oleracea* var. *capitata* (cabbage), *Bromus catharticus* (prairie grass), *Calendula* spp. (marigold), *Cucurbita* spp. (squash), *Daucus carota* (carrot), *Elymus repens* (couch grass), *Eucalyptus saligna* (blue gum), *Fragaria* x *ananassa* (strawberry), *Lactuca sativa* (lettuce), *Nicotiana tabacum* (tobacco), *Olea* spp. (olives), *Oryza* spp. (rice), *Paspalum nicorae* (Brunswick grass), *Pennisetum clandestinum* (kikuyu grass), *Petunia* spp. (petunia), *Phaseolus vulgaris* (bean), *Phlox* spp. (phlox), *Pisum sativum* (pea), *Protea* spp. (protea), *Rheum* x *rhabarbarum* (rhubarb), *Saccharum officinarum* (sugarcane), *Secale strictum* subsp. *strictum* (perennial rye), *Solanum lycopersicum* (tomato), *Sorghum* spp. (sorghum), and *Triticum aestivum* (wheat) (Litsinger et al., 1986; CABI, 2007; Gordh and Headrick, 2011).

Pathogens or Associated Organisms Vectored

Heteronychus arator is not currently known to vector any pathogens or other associated organisms.

Known Distribution

Africa: Angola, Botswana, Comoros, Congo, Democratic Republic of the Congo, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Saint Helena, South Africa, Tanzania (including Zanzibar), Zambia, and Zimbabwe; **Oceania:** Australia, New Zealand, and Norfolk Island (CABI, 2007).

There are a few records for South America, Central America, and Papua New Guinea, but they are not considered reliable (EPPO, 2012).

Pathway

This species has not been identified at any ports of entry, although the genus has been intercepted four times from 1988 to 2004 (AQAS, 2011, queried July 22, 2014). Interceptions of *Heteronychus* occurred twice on material from South Africa (where *H. arator* is known to occur), and once each from Guatemala and Switzerland, all of which were live adults (AQAS, 2011, queried July 22, 2014). One of the South African interceptions occurred on miscellaneous cargo and the other on fruit of *Malus domestica* (apple) (AQAS, 2011, queried July 22, 2014). This suggests that this genus, and possibly this species, can travel internationally on non-host material as hitchhiker pests.

Flying by adults is limited while the other life stages spend their entire time below ground. Natural movement by all stages is thus limited.

Potential Distribution within the United States

The current distribution in Australia and New Zealand of *H. arator* indicates that many regions in the United States may be climatically suitable for the beetle. It is found throughout coastal mainland Australia (north to Brisbane and south to Melbourne) and found in coastal South and Western Australia. *Heteronychus arator* is also a pest on the North Island of New Zealand. Computer projections for Australia indicate a potential distribution from northern Queensland to southern Tasmania. These areas would correspond to plant hardiness zones 7 through 11 in the United States.

Survey

CAPS-Approved Method*:

Visual survey is the approved survey method for *H. arator.*

Adult damage to plants typically involves chewing of the cortex of stems just below the surface of the ground.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Survey Site Selection:
Black maize beetles eat the cuttings and rootlings at or just below ground level, ring bark the vine, and cause wilting and collapse. The problem is greatest where vines have been planted onto old pasture land, especially if kikuyu (*Pennisetum clandestinum*) is present (known to occur in California, Hawaii, Puerto Rico, and USVI (USDA-NRCS, 2014).

Crops planted in heavy, moist soils in low-lying areas seem to be at the greatest risk of attack in Africa.

Time of year to survey:
Most damage by the black maize beetle occurs during the spring to early summer when the adults are most actively crawling on the soil surface. Damage often occurs again after new adults emerge in mid-summer to fall.

Literature-Based Methods:
Visual survey: Areas that are rotated with or replace pasture lands are most at risk of damage from the black maize beetle. Black maize beetles eat the cutting and rootlings at or just below ground level, ring bark the vine, and cause wilting and collapse. Inspect immediately below the soil surface for signs of *H. arator* attack; in particular, look for frayed chewing around the stem circumference.

In grass and turf, heavy infestations can be detected by lifting up tufts of grass and inspecting for abundant frass or distinct channeling of soil with embedded larvae. Less dense infestations will be evident if sections of grass are dug and examined for presence of larvae or adults.

Sampling: Matthiessen and Learmonth (1993) devised a method for sampling *H. arator* in potato crops where the pest was known to be present. A modified version of their approach may be useful for surveys in other corps. In their survey, 50 cm (20 in) long portions of hilled-up rows comprised the sample unit. A 70 x 30 cm (28 x 12 in) piece of sheet steel is pressed into soil across the row with soil on one side of the metal sheet being excavated. The steel sheet is then removed to expose an undisturbed soil face of the potato hill. Presence of the beetle or other pests and associated plant damage in the top, center, or bottom of soil cross sections is recorded. Fifty samples were examined at each sampling time in a uniform grid across a 0.2 ha (0.49 acres) crop area.

Soil sampling is also used to monitor populations of *H. arator* in Australia. Adults were counted from shovels full of soil, and six beetles per square meter represented a potentially damaging population (Matthiessen and Learmonth, 1998). To estimate the density of *H. arator* in pastures 100 soil core samples, 10 cm (approx. 4 in) in diameter x 15 cm (approx. 6 in) deep were used. The soil cores were broken up at the time they were taken and searched only for easily seen large life stages of *H. arator* that occur in the summer and autumn (Matthiessen and Ridsdill-Smith, 1991). King et al. (1981c) collected cores and extracted the large insect stages by dry sorting of the sample cores; eggs and small larvae were separated from the soil using the flotation and wet-sieving technique of Kain and Atkinson (1976).

<u>Trapping:</u> Matthiessen and Learmonth (1998) used pitfall (Fig. 6), light, and window traps to monitor *H. arator* in Australia. Light traps are often used in Australia to monitor adult flight activity during the summer and fall prior to planting on old pasture or potato land. Light traps were similar to a Pennsylvania trap (Southwood, 1978). The light was a vertically-oriented 60 cm-long (approx. 23 $^{5}/_{8}$ in) 20 watt fluorescent black light, the center of which was 1.5 meters (4.92 feet) above the ground. Four vertically-oriented 17.5 cm (approx. 7 in) wide panels equi-radial from the light served as baffles to arrest the flight of insects attracted to the light, causing them to fall through a 21 cm (approx. 8 $^{1}/_{4}$ in) diameter funnel into a collecting container holding an insecticidal vapor strip. A timer kept the light on daily from sunset to sunrise. Light traps were cleared weekly.

Figure 6. Example of a pitfall trap. Photo courtesy of Mnolf. http://commons.wikimedia.org/wiki/File:Barber_pitfall_trap.jpg

Because the beetles are clumsy walkers, they can be collected by pitfall traps or sharp sided plough lines. Matthiessen and Learmonth (1998) made pitfall traps from a 21 cm (approx. 8 $^{1}/_{4}$ in) diameter funnel fitted at ground level into a buried PVC cylinder. Insects fell into a 21 cm (approx. 8 $^{1}/_{4}$ in) plastic jar containing 500 ml (16.91 oz) of 1:1 ethylene glycol and water. Mesh panels on the upper sides of the collecting jar allowed rainfall to drain away. These traps were spaced at 10 meter (approx. 33 feet) intervals at one location. Subsequent traps were made from a 10 cm (approx. 4 in) diameter plastic funnel glued into the screw-top lid of a 250 ml (8.45 oz) plastic jar. These smaller traps were more easily placed in pasture by creating a hold with a 10 cm (approx. 4 in) diameter corer, and inserting the whole trap assembly. No preservative was used for these smaller traps due to the small size and absence of large predators capable of consuming adult *H. arator*. The narrow neck of the funnel fastened into the lid prevented escape of beetles, and holes at the base of the collecting jar allowed drainage. Typically, ten traps were deployed, at 5 meter (approx. 16 $^{1}/_{2}$ feet) intervals in each of two lines 10 meters (approx. 33 feet) apart. Captures in all pitfall traps were assessed weekly.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at: http://caps.ceris.purdue.edu/.

Key Diagnostics/Identification

CAPS-Approved Method*:

Confirmation of *H. arator* is by morphological identification. Adult identification should be confirmed by individuals with expertise in the Pentodontini tribe. Diagnostic images can be found here: http://www.padil.gov.au/pests-and-diseases/Pest/Main/135883#.

Keys to identify adults from related species are given by Enrodi (1985).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at: http://caps.ceris.purdue.edu/.

Easily Confused Species

This species is a member of the tribe Pentodontini and will generally resemble many of the native members of this tribe in North America. Possible look-alikes in the tribe Pentodontini include members of the genera *Aphonides*, *Aphonus*, *Coscinocephalus*, *Euetheola*, *Gillaspytes*, *Orizabus*, *Oxygyrlius*, and *Tomarus*. Some *Dyscinetus* spp. (tribe Cyclocephalini) may also be mistaken for *H. arator*. Two native species of Pentodontini that may be confused for *H. arator* include *Euetheola hu*milis (sugarcane beetle) and *Tomarus gibbosus* (carrot beetle) (B. Brown, per. comm., 2012). A key to differentiate the genera of the tribe Pentodontini can be found online at: http://www-museum.unl.edu/research/entomology/Guide/Scarabaeoidea/Scarabaeidae/Dynastinae/Dynastinae-Tribes/Pentodontini/Pentodontini-Key/PentodontiniK.html.

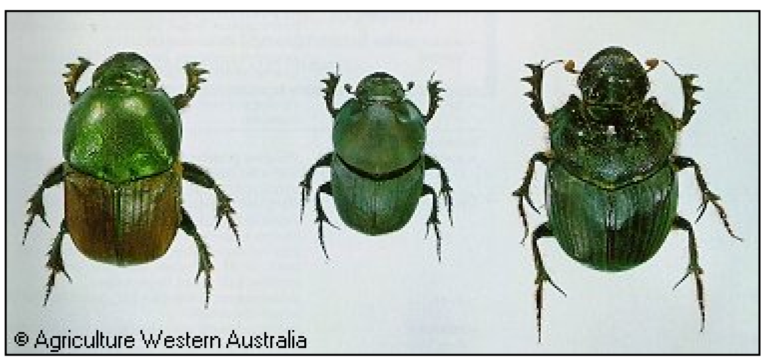

Figure 7. Dung beetles *Onitis alexis* (left), *Onthophagus binodis* (center), and *Onthophagus ferox* (right). Photo courtesy of Agriculture Western Australia.

The adults of *H. arator* may be confused with the red headed pasture cockchafer (*Adoryphorus coulonii*). In dorsal view, the *H. arator* body shape is almost parallel compared to distinctly oval in *A. coulonii*. The elytra of *H. arator* is weakly impressed with longitudinal striae and indistinctly punctuate between striae compared to *A. coulonii* elytra, which has deeply impressed striae and distinctly punctuate between striae. *Australaphodius frenchi* and *Adoryphorus coulonii* are not currently present in the United States. *Heteronychus arator* may also be confused with the dung beetles *Onitis alexis*, *Onthophagus binodis*, and *Onthophagus ferox*; *Onitis alexis* is present in the United States while *Onthophagus binodis* and *Onthophagus ferox* are not (Fig. 7) (Department of Agriculture, Government of Western Australia, 2005).

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Revisions

July 2014

1) Added Figures 3 and 4. Lateral and dorsal views of *Heteronychus arator* adult.
2) Revised the **Damage** section.
3) Revised the **Known Distribution** section.
4) Revised the **Survey** section.
5) Revised the **Key Diagnostics/Identification** section.
6) Revised the **Easily Confused Species** section.