Prepared by CABI and EPPO for the EU
under Contract 90/399003

Data Sheets on Quarantine Pests

Anthonomus quadrigibbus

IDENTITY

Name: *Anthonomus quadrigibbus* Say
Synonyms: *Tachypterus quadrigibbus* Dietz
Tachypterellus quadrigibbus Fall & Cockerell
Tachypterellus quadrigibbus magnus List
Tachypterellus consors cerasi List
Taxonomic position: Insecta: Coleoptera: Curculionidae
Common names: Apple curculio, Western curculio, large apple curculio (English)
Bayer computer code: TACYQU
EU Annex designation: II/A1 - as *Tachypterellus quadrigibbus*

HOSTS

A. quadrigibbus is associated with a wide range of plants in the Rosaceae and, apparently, with *Cornus stolonifera* (Cornaceae). In addition, Burke (1976) mentioned that this species may also develop in the fruit of *Melia azedarach*. Apples and *Crataegus* spp. are the usual host plants. Burke & Anderson (1989) gave the following list of Rosaceae from which the adults have been reared or collected: *Crataegus mollis*, *C. holmesiana*, *C. crus-galli*, *C. punctata*, *C. macrosperma*; apples and *Malus coronaria*; *Prunus serotina*, *P. demissa*, *P. emarginata*, *P. virginiana*, *P. cerasus*; pears; *Amelanchier alnifolia*; *Sorbus* sp. *Crataegus* is a common host in eastern but not in western North America; apples serve as hosts in the eastern and midwestern portions of the range; cultivated cherries are a significant host only in Colorado, although various other wild *Prunus* species are hosts over a broad area of the range of the species; and *Amelanchier* is a host in eastern and central North America but not in western North America where only *Anthonomus consors* is associated with plants of this genus (Burke & Anderson, 1989).

In the EPPO region, the cultivated hosts are grown throughout the region, and the genera *Crataegus*, *Prunus* and *Sorbus* are well represented in the wild flora.

GEOGRAPHICAL DISTRIBUTION

EPPO region: Absent.
North America: Canada (Nova Scotia to British Columbia), the most northerly record is from the Grand Prairie region, Alberta (Burke & Anderson, 1989); Mexico (the most southerly record is from Mexico state); USA (recorded from every state except Nevada and Wyoming, where it probably also occurs (Burke & Anderson, 1989).
EU: Absent.
Distribution map: See Burke & Anderson (1989).

BIOLOGY

Adult weevils overwinter on the ground beneath the trees. They begin to emerge when the ground surface temperature is about 16°C or above for at least 24 h and fly strongly when the temperature is much higher. In the Champlain Valley, New York (USA), emergence usually starts in early May. Adults disperse actively in the spring, seeking the most suitable hosts. At first they feed on leaf petioles, flower buds, and then on blossoms and finally on small fruits as soon as they have set.

There is considerable migration in the spring from one host to another as fruit is set, the beetles showing a preference for smaller fruit (Hammer, 1936). Ritcher (1936) showed that beetles reared from *Crataegus* and apple both preferred to oviposit on the host from which they were reared. However, if the preferred host is not available, the beetles will readily disperse to, and oviposit on, the same or a different host some distance away (List, 1932; Hammer, 1936).

Mating takes place soon thereafter and then egg laying which may be prolonged up to 60 days or more; the mean period is 34.6 days, during which a mean of 65.8 eggs can be laid by a single female (Crandall, 1905). The eggs are deposited in cavities made in maturing fruits, only one egg per large apple. On cherries, the eggs may be deposited either directly in the seeds or in the flesh of the fruit; most females apparently do the latter (List, 1932). Eggs may be deposited in both ovaries and flesh of apples (Crandall, 1905).

Incubation requires about 7 days and the larvae feed by enlarging the oviposition cavity. According to Burke & Anderson (1989), the larvae feed primarily upon the seed(s), although they may also be found in the flesh of the fruit. Apparently they do not tunnel through the fruit like *Conotrachelus nenuphar*, but feed within a cavity (Hammer, 1936).

The majority of larvae in apples that fall in the "June drop" as well as those in apples remaining on the trees, develop successfully. There are three larval instars and pupation usually occurs in the fruit while it is still on the tree. There is considerable mortality in growing fruit due to pressure on the larva or pupa (Hammer, 1936). Larvae also develop in mummified apples that remain on the trees (Hammer, 1933). The newly emerged adults eat their way out.

Data on development rates in different types of apples are given by Hammer (1936). In Maine (USA), 80% of adults had emerged by mid-August (Lathrop, 1955) and the last emerged in New York in mid-September (Hammer, 1936). This species is univoltine. Aspects of the biology of *A. quadrigibbus* were given by Fulton (1928), Hammer (1933; 1936), Ritcher (1936) and Lathrop (1955).

DETECTION AND IDENTIFICATION

Symptoms

The first signs of injury are usually tiny punctures through the skin of the fruitlets. Beneath the punctures, the weevils dig out cavities for feeding or oviposition. If for the latter, they are closed with a pellet of frass. As the fruit grows these punctures are left at the bottom of funnel-shaped pits and the apple becomes misshapen. The egg puncture is wider toward the bottom, whereas the feeding puncture is somewhat parallel-sided; however, the two types of punctures are virtually indistinguishable on the surface of the fruit (Burke, 1976). Larvae, pupae and adults can be found in mature apples. Feeding on maturing fruit by the new generation of adults produces collapsed brown spots that can coalesce to form areas up to 2.5 cm in diameter (Hammer, 1932). Damage is well figured by Fulton (1928) and Hammer (1932; 1936). Rots and other pests may enter through punctures (Hammer, 1936). Photographs showing adult feeding punctures on berries of saskatoons, larval feeding damage within berries and damage to seeds were given by Steeves *et al.* (1979).

Morphology

Eggs

White, ovoid, laid in cavity in the fruit whose opening is sealed with frass, one egg per cavity (Hammer, 1936).

Larva

Final instar: 7.5-9.0 mm body length; body white or cream, legless, robust, curved, asperities very small, tubercle-like, generally distributed over entire surface; head light yellowish-brown, sides rather strongly rounded, width 0.77-0.88 mm (mean 0.82 mm), mandibles brown or black. For a key to the known larvae of the tribe Anthonomini, a detailed description of the larva of *A. quadrigibbus* and a good habitus figure, see Ahmad & Burke (1972).

Pupa

Length 4.7-5.5 mm (Burke, 1968), whitish, darkening as development progresses; elytra each with a large, conical tubercle at about the middle; four pairs of discotergal setae on most abdominal terga; abdominal segment 9 bearing one posterior process; in a cavity in the fruit (Hammer, 1936). For a key to the known pupae of the tribe Anthonomini, a detailed description of the pupa of *A. quadrigibbus*, and a good habitus figure, see Burke (1968).

Adult

Body length including rostrum 5.0-11.0 mm (Hammer, 1936), excluding rostrum 2.5-5.5 mm (Burke & Anderson, 1989); brown, lacking the whitish elytral markings of *Conotrachelus nenuphar* (EPPO/CABI, 1996); antennal club elongate, as long as, or longer than, six preceding segments of funicle combined (as compared with the related *A. consors* in which the club is stout, distinctly shorter than the six preceding segments of the funicle combined); rostrum long, slender, curved, one third to one half of overall body length (Hammer, 1936); scutellum narrow, convex dorsally; pronotum and elytra with dorsal pubescence dense and coarse; pronotum distinctly narrower than elytra at base; elytra with distinct, small to large tubercle on interval 3 at declivity, transverse, sub-basal depression poorly to moderately strongly developed; alternate elytral intervals slightly more convex, irregular in width; humeri strongly rounded (Burke & Anderson, 1989).

Size is very variable and host-dependent (Burke & Anderson, 1989); sexual dimorphism is slight with the females usually slightly larger than males as is the length of the rostrum relative to body length; elytral tubercle development is variable and is possibly related to body size but allometry has not been proved (Burke & Anderson, 1989).

MEANS OF MOVEMENT AND DISPERSAL

The adults are strong fliers and can disperse the species locally. Larvae, pupae or newly emerged adults could be transported in apples, but there are no records of their interception. Adults could occur as contaminants of fresh fruit and in soil and debris around trees that have fruited, but such pre-diapause individuals are unlikely to have mated.

PEST SIGNIFICANCE

Economic impact

Riley (1871) noted *A. quadrigibbus* as destructive to cultivated apples and pears. It has since been reported as a pest of cultivated apples in several northeastern and mid-western states of the USA as well as in eastern Canada (Crandall, 1905; Fulton, 1928; List, 1932; Hammer, 1936). According to Metcalf & Flint (1962) it can cause very severe damage to apples, locally inflicting more than 50% crop losses. In Maine, injury to apples may occasionally be severe in heavily infested orchards (Lathrop, 1955). List (1932) mentioned

that *A. quadrigibbus* was first recorded damaging cultivated cherries in Colorado (USA) in 1914 and later became a serious pest. Hoerner & List (1952) reported it causing serious damage to cherries in northern Colorado in 1945. Buckell (1930) described damage to cultivated pears by *A. quadrigibbus* in the Salmon Arm area of British Columbia (Canada) during the growing seasons of 1927-1929. Considerable damage occurred to pears, but apples and cherries in the same orchard showed no sign of injury. It may be noted that all the references cited here are at least 30, and most over 50 years old.

Control

Apparently there are no recently published accounts on the control of this weevil. Buckell (1930) recommended that thickets of wild crab apple and hawthorn in the vicinity of orchards should be destroyed to decrease natural breeding places. Sprays or dusts of various insecticides acted as a deterrent. The beetles often attack the foliage or tender twigs just before or during the blossoming period, and therefore the pink-bud application should be delayed as long as possible. As soon as the fruits begin to form, the beetles start to injure them. This occurs before nearly all the petals have fallen and therefore the calyx application should be made sooner than is usually the case or when 60% of the petals have fallen.

Unfortunately, the weevils may not attack the fruit until some time after the calyx period and in order to control such late infestations, an application should be made as soon as the beetles are noticed or a week later than the calyx spray. According to Hammer (1932), insecticide sprays applied during the adult feeding and oviposition period in the spring appeared to give measurable control. Hammer (1933) suggested that drops should be picked up at least twice, but even where this is done, many of the beetles will emerge from apples on the trees and thus lower the efficiency of this method of control.

Hammer (1936) listed seven species of parasite of *A. quadrigibbus* in New York and mentioned the occurrence of parasitic fungi. It was also mentioned that the larvae are killed by larvae of *Cydia pomonella* and *Conotrachelus nenuphar* when these occur in the same small fruits. Bugbee (1967) reported *Eurytoma fusca* and *E. mali* (Hymenoptera: Eurytomidae) as parasites of this weevil. Burke (1976) summarized in table form the reported hymenopterous parasites of *Anthonomus* species.

Phytosanitary risk

A. quadrigibbus is not currently listed as a quarantine pest by EPPO or by other regional plant protection organizations. Within EPPO, it was considered that measures already recommended for other North American fruit pests would adequately protect against its introduction. Thus, it was considered as a quarantine pest against which it was not necessary to take specific measures (including listing). Conditions in the EPPO region seem suitable for the survival and multiplication of the species including the presence of wild *Crataegus* spp. to support reservoir populations. The fact that there is little recent information about it from North America suggests strongly that modern insecticide treatment regimes reduce it to insignificance (as has happened with other fruit tree pests throughout the world). The same would very probably be true in the EPPO region.

PHYTOSANITARY MEASURES

For other North American fruit pests, EPPO recommends (OEPP/EPPO, 1990) that fruit should come from an area where the specific pest does not occur and/or where routine intensive control measures are being applied. Plants of host species transported with roots should be free from soil, or the soil should be treated against the pest, and they should not carry fruit.

BIBLIOGRAPHY

Ahmad, M.; Burke, H.R. (1972) Larvae of the weevil tribe Anthonomini (Coleoptera: Curculionidae). *Miscellaneous Publications of the Entomological Society of America* **8**, 31-81.

Buckell, E.R. (1930) The apple curculio as a pear pest in British Columbia. *Canadian Entomologist* **62**, 47-49.

Bugbee, R.E. (1967) Revision of chalcid wasps of genus *Eurytoma* in America north of Mexico. *Proceedings of the United States National Museum* **118**, 433-552.

Burke, H.R. (1968) Pupae of the weevil tribe Anthonomini (Coleoptera: Curculionidae). *Technical Monographs, Texas Agricultural Experiment Station* **5**, 1-92.

Burke, H.R. (1976) Bionomics of the anthonomine weevils. *Annual Review of Entomology* **21**, 283-303.

Burke, H.R.; Anderson, R.S. (1989) Systematics of species of *Anthonomus* Germar previously assigned to *Tachypterellus* Fall and Cockerell (Coleoptera: Curculionidae). *Annals of the Entomological Society of America* **82**, 426-437.

Crandall, C.S. (1905) The curculio and the apple. *Bulletin of the University of Illinois Agricultural Experiment Station* **98**, 467-560. (Cited by Burke & Anderson (1989)).

EPPO/CABI (1996) *Conotrachelus nenuphar*. In: *Quarantine pests for Europe*. 2nd edition (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.). CAB INTERNATIONAL, Wallingford, UK.

Fulton, B.B. (1928) The apple curculio and its control by hogs. *Journal of Agricultural Research* **36**, 249-261.

Hammer, O.H. (1932) Studies on control of the apple curculio in the Champlain Valley. *Journal of Economic Entomology* **25**, 569-575.

Hammer, O.H. (1933) Further studies on the control of the apple curculio in the Champlain Valley. *Journal of Economic Entomology* **26**, 420-424.

Hammer, O.H. (1936) The biology of the apple curculio (*Tachypterellus quadrigibbus* Say). *Technical Bulletin of the New York State Agricultural Experiment Station* **240**, 1-50. (Abstract in *Review of Applied Entomology, Series A* **25**, 343-345).

Hoerner, J.L.; List, G.M. (1952) Controlling cherry fruitworm in Colorado. *Journal of Economic Entomology* **45**, 800-805.

Lathrop, F.H. (1955) Apple insects in Maine. *Bulletin of Maine Agricultural Experiment Station* **540**, 26-27.

List, G.M. (1932) A cherry pest in Colorado. *Bulletin of the Colorado State University Agricultural Experiment Station* **385**, 1-106. (Cited by Burke & Anderson (1989)).

Metcalf, C.L.; Flint, W.P. (1962) *Destructive and useful insects*. 4th edition (revised). McGraw Hill, New York, USA.

OEPP/EPPO (1990) Specific quarantine requirements. *EPPO Technical Documents* No. 1008.

Riley, C.V. (1871) The apple curculio. *Third annual report of the noxious, beneficial and other insects of the State of Missouri* 29-35. (Cited by Burke & Anderson (1989)).

Ritcher, P.O. (1936) Larger apple curculio in Wisconsin. *Journal of Economic Entomology* **29**, 697-701.

Steeves, T.A.; Lehmkuhl, D.M.; Bethune, T.D. (1979) Damage to saskatoons, *Amelanchier alnifolia*, by the apple curculio, *Tachypterellus quadrigibbus* (Coleoptera: Curculionidae). *Canadian Entomologist* **111**, 641-648.