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Data Sheets on Quarantine Pests

Sternochetus mangiferae

IDENTITY

Name: *Sternochetus mangiferae* (Fabricius)
Synonyms: *Cryptorhynchus mangiferae* Fabricius
Acryptorhynchus mangiferae (Fabricius)
Taxonomic position: Insecta: Coleoptera: Curculionidae
Common names: Mango seed weevil, mango weevil, mango nut or stone weevil (English)
Charançon de la graine du manguier, charançon de la mangue (French)
Bayer computer code: CRYPMA
EU Annex designation: II/B

HOSTS

Complete development is only achieved in mangoes. In the laboratory, oviposition was obtained on potatoes, peaches, *Litchi chinensis*, plums, *Phaseolus vulgaris* and several cultivars of apples, but all of the resulting larvae failed to reach maturity (Woodruff, 1970). Within the EPPO region, mangoes are grown to a limited but increasing extent around the Mediterranean, for example in Spain (the Canary Islands), Italy, Israel and Egypt (Anon., 1988b).

GEOGRAPHICAL DISTRIBUTION

EPPO region: Absent.
Asia: Bangladesh, Bhutan, China (unconfirmed), Hong Kong, India, Indonesia, Malaysia (Peninsular, Sabah), Myanmar, Nepal, Oman (intercepted only), Pakistan, Philippines (doubtful, see below), Sri Lanka, Thailand, United Arab Emirates, Viet Nam.

According to Anon. (1989a), *S. mangiferae* does not occur in the Philippines. However, it has been intercepted on numerous occasions in mangoes from the Philippines by the Animal and Plant Health Inspection Service of the United States Department of Agriculture (Anon., 1988a).
Africa: Central African Republic, Gabon, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mauritius, Mozambique, Nigeria, Réunion, Seychelles, South Africa, Tanzania,Uganda, Zambia.
North America: USA (Hawaii only. There have been reports from Californa and Florida, but these are interceptions only).
Central America and Caribbean: Barbados, Dominica, Guadeloupe, Martinique, St. Lucia, Trinidad and Tobago, United States Virgin Islands.
South America: French Guiana.
Oceania: Australia, Fiji, French Polynesia (Society Islands), Guam, New Caledonia, Northern Mariana Islands, Tonga, Wallis and Futuna Islands.
EU: Absent.
Distribution map: See IIE (1995, No. 180).

BIOLOGY

In Tamil Nadu, India, adults feed on leaves and tender mango shoots in March and April (Subramanyam, 1926). They are nocturnal and usually feed, mate and oviposit at dusk. They have well-developed wings and fly readily. After emergence, adults enter a diapause, the duration of which varies with the geographic range. For example, in southern India all adults emerging during June enter a diapause from July until late February in the following year (Shukla & Tandon, 1985). The beginning and end of diapause seem to be associated with long-day and short-day photoperiod, respectively (Balock & Kozuma, 1964).

Shukla & Tandon (1985) found that females began oviposition 3-4 days after mating when fruit was about marble-size. Oviposition commenced in about mid-March and reached a peak during the first week of April. The oviposition period varies from 3 weeks (Subramanyam, 1926), 4 weeks (Hansen *et al.*, 1989) to about 5 weeks (Shukla & Tandon, 1985). Females select fruit at random (Hansen *et al*., 1989) from half mature to ripe, and lay eggs singly on the skin or sometimes on the stems; most eggs are laid on the sinus of the fruit (Shukla *et al*., 1985). The female makes a boat-shaped cavity in the epicarp into which an egg is deposited. She then covers each egg with a brown exudate and cuts a crescent-shaped area 0.25-0.50 mm in the fruit near the posterior end of the egg. The wound creates a sap flow, which solidifies and covers the egg with a protective opaque coating. One female may lay 15 eggs per day, with a maximum of almost 300 over a 3-month period in the laboratory (Balock & Kozuma, 1964).

Adults are capable of surviving long unfavourable periods. During non-fruiting periods, weevils diapause under loose bark on mango tree trunks and in branch terminals or in crevices near mango trees (Van Dine, 1907; Balock & Kozuma, 1964). A few adults live through two seasons with a diapause period between.

Incubation requires 5-7 days, depending on season and temperature (Balock & Kozuma, 1964). After hatching, the larva burrows through the flesh and into the seed. As fruit and seed develop, the tunnel and seed entry are completely obliterated so that in time it is impossible to distinguish infested from non-infested seeds unless they are cut open. The minimum time from hatching to seed penetration is 1 day. Larvae can penetrate the seed coat of younger fruit of all varieties but apparently find entry impossible on the mature seed of the variety Itamaraca (Balock & Kozuma, 1964). Complete larval development usually occurs within the maturing seed, but also very occasionally within the flesh (Balock & Kozuma, 1964; Hansen *et al*., 1989). If seeds are not required for weevil development, then, in the case of seedless cultivars, plant resistance must be based on another mechanism for crop protection. In southern India, larvae developed in the field between March and May and pupated in late May and early June, taking about a month to develop (Shukla & Tandon, 1985). In Hawaii the larval period ranged from 22 days to 10 weeks (Balock & Kozuma, 1964; Hansen *et al*., 1989). There are five or seven larval instars (Balock & Kozuma, 1964; Seo *et al*., 1974; Shukla & Tandon, 1985; Hansen *et al*., 1989). Pupation usually occurs within the seed and rarely in the flesh. The pupal period lasts about a week (Subramanyam, 1926; Balock & Kozuma, 1964; Shukla & Tandon, 1985). In Hawaii, Hansen *et al*. (1989) found pupae from the end of May until about mid-July.

Upon maturation, the adults rapidly move out of the seeds and seek hiding places by crawling rather than flying. Adults of the new generation emerge during June in Bangalore, India (Shukla & Tandon, 1985). Often only one adult will mature in each seed, but as many as six have occasionally been recorded. Adults cut their way out of the naked seed, usually via a small circular hole made in the concave edge of the endocarp, usually within a month or two after the fruit falls and decays. On rare occasions weevils may emerge from the seed before fruit fall and eat their way through the flesh of the ripe fruit, ruining it completely.

The estimated time required for development from egg to adult was 35-54 days (Van Dine, 1907; Shukla & Tandon, 1985).

DETECTION AND IDENTIFICATION

Symptoms

Infected fruits are difficult to detect since usually no damage is visible externally. Incisions made by ovipositing females are small and generally soon heal (Kalshoven, 1981). Fruits are not adversely affected by infestation except in rare instances where larvae feed and pupate within the pulp or when they emerge from seeds and tunnel up through the pulp (Balock & Kozuma, 1964). In South Africa, Kok (1979) showed that after harvest of late-maturing varieties, adults tended to leave the seed and tunnel through the fruit, leaving a scar on the outside which served as a site for secondary fungal infection; this renders the fruit unfit for human consumption. Internally infected fruits rot from the outer surface of the stones. The stones also show holes and the cotyledons turn black and remain merely a rotten mass. Seeds, in which the embryo is damaged and the reserve of food in the cotyledons is greatly reduced, fail to germinate.

Morphology

Eggs

Creamy-white when freshly laid; elliptical, 0.72-0.87 mm (mean 0.79 ± 0.20 mm) long and 0.24-0.34 mm (mean 0.29 ± 0.01 mm) wide.

Larva

First-instar body white, legless, elongate, cylindrical, extremely slender, 1.34-1.44 mm (mean 1.39 ± 0.01 mm) long, 0.30-0.41 mm (mean 0.35 ± 0.02 mm) wide; head black. Final (4th or 5th) instar body white, legless, curved, typical curculionoid form, 16.0-18.0 mm (mean 16.7 ± 0.28 mm) long, 6.0-9.0 mm (mean 8.0 ± 0.32 mm) wide (Shukla & Tandon, 1985); head black, not retracted into prothorax, pronotal plate strongly transverse, typical abdominal segment tripartite, terga without coarse asperities, spiracles annular biforous. A detailed description of the larva with diagnostic characters separating it from that of *Sternochetus frigidus* has not been published. The larva of *S. frigidus* was described by Gardner (1934) and Rahman & Ahmad (1972).

Pupa

Whitish when newly formed, changing to a very pale-red just prior to adult eclosion; 7.0-10.0 mm (mean 8.6 ± 0.27 mm) long, 6.0-8.0 mm (mean 6.95 ± 0.22 mm) wide; abdominal apex with paired urogomphi.

Adult

Body compact, 7.5-9.5 mm long, black, covered by black, greyish or yellowish scales; pronotum subparallel-sided in basal third only; elytra with interstices 3, 5 and 7 strongly carinate, indistinct oblique pale humeral stripe, elongate (6:4), gradually declivous behind; femora with single large tooth ventrally, profemora stout, distinctly clavate; tarsal claws simple, free; female with elevated ridge at pygidial apex, absent in male. Similar to *S. frigidus* in which the pronotum is parallel-sided in basal half, elytra shorter (5:4), strongly declivous behind, profemora slender, not clavate.

For keys to related Oriental genera, including *Sternochetus*, see Morimoto (1978). A key to Indian species was given by Marshall (1935).

MEANS OF MOVEMENT AND DISPERSAL

Adults usually remain in the vicinity of the parent tree until the following fruiting season (Jarvis, 1946) and high infestations appear year after year in some locations and low infestations appear in others (Balock & Kozuma, 1964). Longer-range dispersal occurs largely through transport of fruit and seeds containing the larvae, pupae or adults. The pest has been intercepted in mango fruits and seeds in international trade (Anon., 1988a; 1989b).

PEST SIGNIFICANCE

Economic impact

No external symptoms of attack by *S. mangiferae* are readily visible on infested fruits, apart from the brown hardened secretion remaining attached to them at the sites of oviposition. Yields are not significantly affected,since the larvae usually feed entirely within the stone,very rarely in the pulp of the fruit. However, postharvest damage to the pulp of late-maturing cultivars by emerging adults occurs in South Africa (Kok, 1979). The adults tunnel through the fruit, leaving scars on the outside which serve as sites for secondary fungal infection. Probably its greatest significance as a pest is to reduce the germination capacity of seeds greatly and to interfere with the export of fruit, because of quarantine restrictions imposed by importing countries. In India, all cultivars are susceptible and levels of infestation vary between 48 and 87% (Bagle & Prasad, 1985).

Control

There is little incentive for growers to attempt control since the fruit is usually unaffected for eating purposes. In nursery beds, far more seeds than are required for the projected number of seedlings can be planted to allow for a low percentage of germination. Alternatively, the seed may be shelled and only sound kernels planted (O'Connor, 1969).

Various control measures have been employed, including good sanitation, chemicals and hot and cold treatments to kill the various stages, and gamma radiation to sterilize and kill the adults still in the fruit. Good orchard sanitation involves the destruction of scattered stones (Kok, 1979) and removal of fallen fruits and their stones (Villiers, 1987). Chemical control has been used with some success and a wide range of insecticides have been recommended (see, for example, Shukla & Tandon, 1985; Villiers, 1987). The main strategy is to attack diapausing adults by trunk applications or to use foliar sprays at the time of oviposition.

Apparently nothing is published concerning the parasites and predators of *S. mangiferae*. The ant *Oecophylla smaragdina* is reported to be a general predator of *Sternochetus frigidus* (Voute, 1935). The only published record regarding pathogens is of a baculovirus affecting the larvae of *S. mangiferae* (Shukla *et al*., 1984).

Phytosanitary risk

S. mangiferae is a quarantine pest for the CPPC, IAPSC, NAPPO and OIRSA. It is not currently listed as a quarantine pest by EPPO. However, as mango production increases in the south of the EPPO region, there is no doubt that *S. mangiferae* could establish and be of economic importance.

PHYTOSANITARY MEASURES

Fruit and seeds of mango containing larvae or pupae present the main risk of introducing *S. mangiferae*, although mango plants with diapausing adults could also be a danger, and such material from countries where the pest occurs may be prohibited by mango-growing countries. Plants for planting (including seeds) of mango may be imported provided that they derive from an area where the pest does not occur and the place of production has been found free from infestation by inspection during the previous growing season.

Imported mango fruit from countries where *S. mangiferae* occurs can be subjected to a quarantine treatment. Methyl bromide fumigation at the rate of 36 gm^3 for 8 h at 21°C gave complete kill of all stages but injured the fruit (Balock & Kozuma, 1964). Balock & Kozuma (1964) found gamma radiation to be the most effective method for killing or sterilizing weevils within fruit. In Hawaii, Seo *et al*. (1974) treated packaged mangoes with cobalt-60 gamma irradiation. Minimum doses of 20.6 and 32.9 krad killed insects of all stages within the fruits; the few surviving adults were sterile and short-lived. In South Africa, irradiation of ripe, marketable fruit protected it from damage and prevented adult emergence. The most effective dosages ranged from 0.5 to 0.85 kGy; higher rates tended to be phytotoxic (Kok, 1979). Hot and cold treatment of fruit has also been tried but gave unreliable results and proved phytotoxic (Balock & Kozuma, 1964; Seo *et al*., 1970; Shukla & Tandon, 1985).

BIBLIOGRAPHY

Anon. (1988a) *List of Intercepted Plant Pests, Fiscal Year 1987*, 194 pp. United States Department of Agriculture, Animal and Plant Health Inspection Service PPQ, Hyattsville, Maryland, USA.

Anon. (1988b) *FAO Production Yearbook* No. 42, pp. 218-219.

Anon. (1989a) *Quarterly Newsletter, Asia and Pacific Plant Protection Commission* **32**, 39-42.

Anon. (1989b) Mango stone weevil in Fiji. *South Pacific Commission Plant Protection News* **21**, 4-5.

Bagle, B.G.; Prasad, V.G. (1985) Studies on varietal incidence and control of stone weevil, *Sternochetus* (=*Crytorrhynchus*) *mangiferae* Fabricius (Coleoptera: Curculionidae). *Indian Journal of Entomology* **47**, 362-364.

Balock, J.W.; Kozuma, T.T. (1964) Notes on the biology and economic importance of the mango weevil, *Sternochetus mangiferae* (Fabricius), in Hawaii (Coleoptera: Curculionidae). *Proceedings of the Hawaiian Entomological Society* **18**, 353-364.

Gardner, J.C.M. (1934) Immature stages of Indian Coleoptera (14) (Curculionidae). *Indian Forest Records (Entomology Series)* **20**, 1-48.

Hansen, J.D.; Armstrong, J.W.; Brown, S.S. (1989) The distribution and biological observations of the mango weevil, *Cryptorhynchus mangiferae* (Coleoptera: Curculionidae), in Hawaii. *Proceedings of the Hawaiian Entomological Society* **29**, 31-39.

IIE (1995) *Distribution Maps of Pests, Series A* No. 180 (3rd revision). CAB International, Wallingford, UK.

Jarvis, H. (1946) Pests of the mango. *Queensland Agricultural Journal* **62**, 10-14.

Kalshoven, L.G.E. (1981) *Pests of crops in Indonesia*, 701 pp. Van Hoeve, Jakarta, Indonesia.

Kok, I.B. (1979) [Control of the mango seed weevil by trapping and irradiation]. *Citrus and Subtropical Fruit Journal* **552**, 14-16.

Marshall, G.A.K. (1935) New Indian Curculionidae (Col.). *Indian Forest Records (Entomology, New Series)* **1**, 205-231.

Morimoto, K. (1978) On the genera of Oriental Cryptorhynchinae (Coleoptera: Curculionidae). *Esakia* **11**, 121-143.

O'Connor, B.A. (1969) *Exotic plant pests and diseases*. 23 [+ 446] pp. South Pacific Commission, Noumea, New Caledonia.

Rahman, M.L.; Ahmad, M. (1972) The immature stages of the mango fruit weevil, *Sternochetus frigidus* Fabricius (Coleoptera: Curculionidae). *Pakistan Journal of Scientific and Industrial Research* **15**, 188-190.

Seo, S.T.; Chambers, D.L.; Komura, M.; Lee, C.Y.L. (1970) Mortality of mango weevils in mangoes treated by dielectric heating. *Journal of Economic Entomology* **63**, 1977-1978.

Seo, S.T.; Kobayashi, R.M.; Chambers, D.L.; Steiner, L.F.; Lee, C.Y.L.; Komura, M. (1974) Mango weevil: Cobalt-60 gamma-irradiation of packaged mangoes. *Journal of Economic Entomology* **67**, 504-505.

Shukla, R.P.; Tandon, P.L. (1985) Bio-ecology and management of the mango weevil, *Sternochetus mangiferae* (Fabricius) (Coleoptera: Curculionidae). *International Journal of Tropical Agriculture* **3**, 293-303.

Shukla, R.P.; Tandon, P.L.; Singh, S.J. (1984) Baculovirus - a new pathogen of mango nut weevil, *Sternochetus mangiferae* (Fabricius) (Coleoptera: Curculionidae). *Current Science* **53**, 593-594.

Shukla, R.P.; Tandon, P.L.; Suman, C.L. (1985) Intra-tree distribution of the eggs of mango stone weevil, *Sternochetus mangiferae* (Fabricius) (Coleoptera: Curculionidae). *Entomon* **10**, 215-218.

Subramanyam, C.K. (1926) A note on the life-history of *Cryptorhynchus mangiferae* Fabricius. *Madras Agricultural Department Yearbook* 1925, pp. 29-36.

Van Dine, D.L. (1907) Notes on *Cryptorhynchus mangiferae* (Coleoptera). *Proceedings of the Hawaiian Entomological Society* **1**, 79-82.

Villiers, E.A. de (1987) [Mango weevil must be controlled]. *Information Bulletin, Citrus and Subtropical Fruit Research Institute, South Africa* **176**, 12-13.

Voute, A.D. (1935) [*Cryptorrhynchus gravis* F. and the causes of its multiplication in Java]. *Archives Néerlandaises de Zoologie* **2**, 112-142.

Woodruff, R.E. (1970) The mango seed weevil, *Sternochetus mangiferae* (Fab.) (Coleoptera: Curculionidae). *Entomology Circular, Florida Department of Agriculture and Consumer Services, Division of Plant Industry* **93**, 1-2.