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CURCULIONIDAE (COLEOPTERA) ASSOCIATED WITH WILD AND CULTIVATED *AMARANTHUS* SPP. (AMARANTHACEAE) IN SOUTH AFRICA

LOUW, S. vdM, C. F. VAN EEDEN[1] and W.J. WEEKS[1]
Department of Zoology and Entomology, University of the Orange Free State,
P.O. Box 339 Bloemfontein, South Africa
[1]Highveld Region, ADI, Private Bag X804, Potchefstroom, South Africa

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ABSTRACT

Seven Curculionidae species were sampled in direct association with wild and cultivated vegetable *Amaranthus* spp. at five localities in central South Africa. These weevils fall within the tribes Lixini (*Hypolixus haerens; Gasteroclisus* cf *cuneiformis; Neocleonus sannio*), Baridini (*Baris* cf *dodonis; Baris* cf *amaranthi; Baris* sp.), and Ceutorhynchini (*Hypurus* sp.), all of which have different infestation patterns on their hosts. Simultaneous infestation by this weevil complex on *Amaranthus* thus implies large-scale damage to the particular plants. Two additional weevil species were also recorded in the vicinity of amaranth fields, but were not observed feeding on the plants. An established weevil parasitoid, *viz. Entedon* sp. (Eulophidae), was also recorded from amaranth plants.

Key Words: **Amaranth, Coleoptera, infestation, pests**

RÉSUMÉ

Sept espèces de *Curculionidae* ont été échantillonées en association directe avec le légume *Amaranthus* spp. sauvage et cultivé dans cinq localitées dans le centre de l'Afrique du Sud. Ces charançons font partie des tribus Lixini (*Hypolixus haerens* ; *Gasteroclisus* cf *cuneiformis*; *Neocleonus sannio*), Baridini (*Baris* cf *dodonis*; *Baris* cf *amaranthi*; *Bari* sp.) et Ceutorrhynque (*Hypurus* sp.) qui ont tous des différentes caractéristiques d'infestation sur leur hôtes. Des infestations simultanées par ce complexe de charançons sur l'*Amaranthus* sous entend donc des dégâts à grande échelle pour la plante en question. Deux espèces supplémentaires de charançons ont aussi été signalés dans la vicinité des champs d'amarantes, mais non pas été observés se nourrissant sur les plantes. Un parasitoide reconnu du charançon c'est à dire le *Entedon* sp (Eulophidae) et le *Iphiaulax* sp (Braconidae) étaient aussi observés parmis les plantes d'amarante.

Mots Clés: **Amarante, Coléoptères, infestation, parasites**

INTRODUCTION

The majority of the approximately 60 species of *Amaranthus* occur in the wild and are regarded as weeds (Brenan, 1981). Throughout the world, however, a limited number of species are cultivated and their grain and/or leaves are utilised for human and animal consumption (Saunders and Baker, 1983; Pond and Lehmann, 1989; Stallkenecht and Schulz-Schaeffer, 1991). In Africa, with its increasing human population, against the background of drought, mismanagement of natural resources and food shortages, amaranth has become a valuable source of human nutrition (e.g. Norman, 1972; Uzo and Okorie, 1983; Chewa, 1985; Gerson, 1991). In southern Africa, where wild amaranth has traditionally been a popular grain and vegetable food source (e.g. Whitbread and Lea, 1982; Ogle and Grivetti, 1985), the cultivation of primarily vegetable amaranth has received considerable attention in central South Africa over the past few years (e.g. van Tonder, 1992).

On *Amaranthus* spp., especially cultivated types, a wide spectrum of insects have been recorded which infest plants in varying levels of intensity and which exploit the plants in one way or another (Weber *et al., 1990;* Wilson, 1990). Of all the insects attacking amaranth, the most prevalent on a world scale are most probably weevils (Coleoptera: Curculionidae) of which not only the adults (as leaf feeders), but also the larvae (as root and/or stem borers) cause considerable damage. Currently weevil infestation on amaranth has been documented from the USA (e.g Landis *et al., 1970;* Weber *et al., 1990;* Wilson, 1990; Stallkenecht and Schulz-Schaeffer, 1991), India (Ahmad, 1938; Gupta and Rawat, 1953; Agrawal, 1985; Beevi and Abraham, 1986), former USSR (e.g. Ramanova, 1928) and Central, West, East and North Africa (Marshall, 1936; Eluwa, 1977; LePelley, 1959; Kolaib *et al., 1986,* respectively), but not from southern Africa.

This paper reports the different weevils associated with amaranth plants in central South Africa. Supplementary synoptic information concerning the biological and ecological habits of the weevils is also supplied. For completeness weevils recorded from fields adjacent to those regularly used for amaranth cutivation, but which are presently not known to utilize amaranth as a host, are also discussed. Finally, brief mention is made of potential weevil parasitoids that were recorded.

MATERIAL AND METHODS

The study is based on sampling carried out on wild amaranth at Wolmaranstad (27° 11'S; 26° 00'E) and Potchefstroom (26° 42'S; 27° 6'E) and on both wild and cultivated amaranth at Bothaville (27° 22'S; 26° 37'E), Brits (25° 38'S; 27° 47'E) and Warmbad (24° 52'S; 28° 19'E). At the Bothaville site, sampling was also conducted on the clean fields shortly before planting commenced. Sampling on wild amaranth served to supplement information concerning weevil incidence on amaranth in general.

At all sites, adult weevils were hand collected. At the Warmbad, Brits and Bothaville sites, during the 1992/93 growing season, whole plants were uprooted prior to harvest or the post-harvest stalks were collected in the fields and all the material transported to the laboratory for dissection. Dissection entailed opening the stalks, stems, crowns and roots of the plants, and inspecting all plant parts for signs of weevil and other insect activity. Dissected weevil materials were treated as follows: larvae were reared through to pupae on an artificial died at 25°C., pupae were maintained on moist tissue paper in petri dishes at 25°C, and adults which were used for identification purposes were caged on potted amaranth to observe feeding, mating and oviposition behaviour, and maintained under glasshouse conditions at controlled temperatures (min. 18°C and max. 28°C; dark : light cycle = 9 : 15 hrs). Dead insects were preserved in Hood's solution.

Voucher material is deposited in the Biosystematics Laboratory, Department of Zoology and Entomology, University of the Orange Free State, Bloemfontein, South Africa.

In order to determine the extent of weevil oviposition on amaranth, five plants were removed at random at more or less regular intervals (*i.e.*, after transplant at 2 week intervals up to 56 days and thereafter once 4 weeks later at 84 days) from a commercial field at Bothaville during 1993/94. These plants were thoroughly inspected for weevil oviposition scars and the loci and number of scars noted. Due to an increasing overall callose appearance of the mainstems, accurate assessment of oviposition loci became impossible, with the result that recordings had to be terminated after 12 weeks.

RESULTS

The seven weevil species recorded from amaranth, together with brief comments on their biological and ecological traits, are presented below.

Hypolixus haerens **(Boheman) (Curculionidae: Curculioninae: Lixini).** This species, which was sampled at all five localities, aggresively attacks amaranth in both the adult and larval stages. Adults chew semi-circles out of the leaf edges and windows in the leaf lamina. Softer leaf stems and growth tips are also utilized. Adult defaecation is visible all over the plants as small, brown blotches. Females cut narrow slits into the plant epidermis, presumably with the ovipositor, and deposited a single egg inside each slit, partially embedding it in the deeper-lying plant tissue (Fig. 1). Oviposition occurs in the main stem, side stems and thicker leaf petioles and ventral portions of the axils of larger leaves. Larvae are endophytic feeders of the stems and crown of the hosts, where infestation levels can be quite severe. This is demonstrated in Table 1 where, at the Bothaville

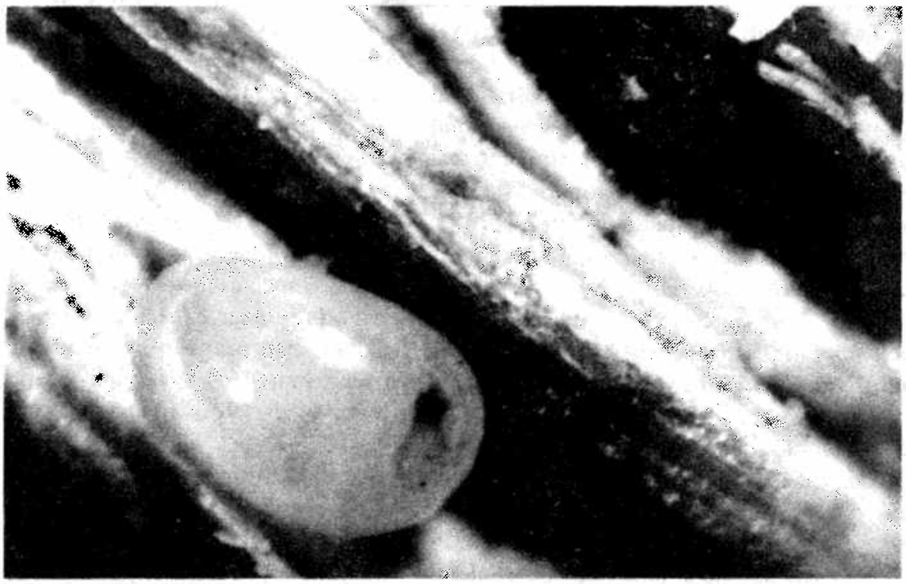

Figure 1. Egg of *Hypolixus haerens* embedded in deeper-lying tissue of an *Amaranthus* stem (X45 life size)

TABLE 1. Ovoposition loci of weevil complex on *Amaranthus* plants at Bothaville site at different time intervals after transplant (five plants investigated per interval)

Plant age after transplant (in days)	$\bar{x}$ no. loci on main stem	$\bar{x}$ no. side stems per plant	$\bar{x}$ no. loci per side stem	$\bar{x}$ no. loci per plant
14	2.8	*	*	2.8
28	8.8	7.8	1.9	18.8
42	7.2	13.8	2.5	41.6
56	6.4	15.4	4.1	69.0
84	5.0	24.5	5.6	136.5

site, weevil oviposition commenced early on the amaranth seedlings and increased drastically as the plants matured. Table 1 also shows that the range of oviposition loci on the main stems of the plants is low and that there is an increase of side stems per plant over time, but that the number of oviposition loci on the side stems still remains low. Overall, however, a high number of oviposition loci, which correlates with the increase in number of side stems, is present per plant, possibly indicating that the weevils prefer young plant growth for oviposition. Larvae apparently do not feed on the roots. Pupation occurs inside the larval tunnels and adults emerge by chewing through the plant walls. Adults are active fliers and readily move around between plants.

***Gasteroclisus* cf. *cuneiformis* (Fahraeus) (Curculionidae: Curculioninae: Lixini).** Adults of this species were sampled at the Brits and Potchefstroom sites on amaranth leaves and causing feeding scars on the plants similar to that of *H. haerens*. Although nothing more is known concerning this species, studies by Eluwa (1977) in Nigeria on a related species suggest traits similar to that of *H. haerens*.

***Neocleonus sannio* (Herbst.) (Curculionidae: Curculioninae: Lixini).** Adults of this species were sampled at Bothaville, Brits and Potchefstroom feeding on young leaves at the growth tips of amaranth plants. The species also occurred in large numbers on the ground between plants. It was also recorded sheltering under *Senecio consanguineus* D.C. (Compositae) plants on open fields adjacent to *Amaranthus* stands. No other data concerning the association of this species with amaranth were obtained.

***Baris* cf. *dodoris* Marshall, *Baris* cf. *amaranth* and *Baris* sp. (Curculionidae: Curculioninae: Baridini).** Adults and larvae of *B.* cf *dodonis* were dissected from the roots and stems of amaranth from Warmbad and Bothaville, whilst under similar conditions *Baris* cf. *amaranthi* were found on plants from Warmbad and *Baris* sp. were found on plants from Brits, Potchefstroom and Bothaville. Dissected material showed the larvae to be endophytic feeders, and pupation to occur inside the larval tunnels. Eggs are also oviposited through a slit into the plant tissue in a manner and on loci similar to those of *H. haerens*. By tracing frass-filled baridine tunnels inside the plants, it was determined that the larvae not only bore up and down the stems, but that they also bore into the taproots. The latter strategy was not observed in *H. haerens*.

***Hypurus* sp. (Curculionidae: Curculioninae: Ceutorhynchini).** A single *Hypurus* specimen was collected from amaranth at the Bothaville site, but nothing concerning its habits was observed. The occurrence of *Hypurus* on *Amaranthus* has been previously documented from India (Beevi and Abraham, 1986). In that paper, brief mention is made of the females of the particular *Hypurus* sp. ovipositing single eggs in chewed-out cavities on amaranth leaves, and that pupation occurs in the soil.

Other weevils

***Microlarinus angustulus* Marshall (Curculionidae: Curculioninae: Lixini).** Adults of this species was sampled at Bothaville sheltering under *Senecio consanguineus* D.C. (Compositae) plants on open fields in close vicinity to amaranth fields. Nothing concerning the hosts of this species or its life history is known.

***Protostrophus sulcatifrons* Marshall (Curculionidae: Entiminae: Brachyderini).** This polyphagous species, known to attack maize and garden plants (Annecke and Moran, 1982), was recorded at Bothaville under similar circumstances as above. Although no detailed life history information concerning this species is available, in general the larvae of *Protostrophus* spp. feed ectophytically on the subterranean plant crown, with pupation occurring in the soil.

Parasitoids. Parasitic Hymenoptera in direct association with amaranth were found on plants from Warmbad. Dissection of plant stems produced pupae of *Entedon* sp. (Eulophidae), a host specific weevil parasitoid (*re* G. L. Prinsloo, personal communication), inside the tunnels bored by *Hypolixus haerens* larvae.

DISCUSSION

The present study, forming part of a larger long-term project on the life-histories of amaranth associated weevils, reports seven weevil species to be directly associated with *Amaranthus*. This species incidence is not only higher in number but also strikingly more varied than the amaranth weevils recorded in other parts of the world. The seven known South African weevils represent five genera in three tribes, whilst, for instance, only five amaranth weevil species (in three genera from two tribes) are known from Kenya and Uganda in East Africa (LePelley, 1959), only three species (in three genera from three tribes) have been recorded in the USA (Landis *et al.*, 1970; Weber *et al., 1990*) and only two species (in two genera from two tribes) are reported from India (Ahmad, 1938; Gupta and Rawat, 1953; Agrawal, 1985; Beevi and Abraham, 1986).

Adults of South African amaranth weevils are most probably all leaf-feeders. Their larvae on the other hand, utilize a number of feeding niches, with Lixini boring endophytically in above-ground parts such as mainstems and larger side stems and plant crowns, Baridini boring endophytically in stems and roots and Ceutorhynchini supposedly developing endophytically in leaf axils and smaller side stems. These weevils thus occupy at least five feeding niches on the amaranth plant. In contrast, the Indian amaranth weevils only exploit above-ground plant parts, whilst, with the exception of *Cylindrocopturus adspersus* Leconte (Weber *et al.*,1990) for which a single opportunistic attack on amaranth stems is reported, the US amaranth weevils seem to only attack below-ground plant parts. Besides showing this high diversity on South African amaranths, the weevils most probably also have high infestation levels on the plants, as reflected in their intense mode of oviposition that appears to continue throughout the season.

The scenario presented here shows that weevils associated with South African amaranths have the potential to heavily infest the plants, occupying the majority of feeding niches available. This poses a real threat to the future of successful, cost effective commercial cultivation of *Amaranthus* in the country.

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REFERENCES

Agrawal, B.D. 1985. Biology of *Hypolixus truncatulus* Fabr. (*Coleoptera: Curculionidae*) forming galls on the stems of *Amaranthus spinosus* Linn. in India. *Cecidologia Internasionale* 6(1/3): 83-90.

Ahmad, T. 1938. The amaranth borer, *Lixus truncatulus* (F.), and its parasites. *Indian Journal of Agricultural Science* 9(4): 609-627.

Annecke, D.P. and Moran, V.C. 1982. *Insects and Mites of Cultivated plants in South Africa.* Butterwoths, Durban. 383 pp.

Beevi, S.P. and Abraham, C.C. 1986. New record of *Hypurus* sp. (*Coleoptera: Curculionidae*) as a pest of *Amaranthus dubius* Ex. Thall. and *Amaranthus tricolor* Linn. *Agricultural Research Journal of Kerala* 24(2): 219-220.

Brenan, J.P.M. 1981. The genus Amaranthus in southern Africa. *Journal of South African Botany* 47(3): 451-492.

Chweya, J.A. 1985. Identification and nutritional importance of indigenous green leaf vegetables in Kenya. *Acta Horticulturae* 153: 98-108.

Eluwa, M.C. 1977. Studies on *Gasteroclisus rhomboidalis* (*Coleoptera: Curculionidae*), a pest of the African Spinach. *Journal of Natural History* 11(4): 417-424.

Gerson, R.T. 1991. Home gardening of indigenous vegetables: the role of women. *Acta Horticulturae* 270: 331-336.

Gupta, R.L. and Rawat, R.R. 1953. Life history of *Hypolixus truncatulus* (Boh.) [= *Lixus brachyrhinus* Boh.] - the rajgira weevil. *Indian Journal of Entomology* 16: 142-144.

Kolaib, M.O., Younes, M.W.F. and Darwish, E.T.E. 1986. *Hypolixus nubilosus* as a factor in biological control of Amaranthus weeds in Egypt. *Annals of Agricultural Science* 31(1): 767-775.

Landis, B.J., Peay, W.E. and Fox, L. 1970. Biology of *Cosmobaris americana* Casey, a weevil attacking sugarbeets. *Journal of Economic Entomology* 63(1): 38-41.

LePelley, R.H. 1959. *Agricultural Insects of East Africa*. East African High Commission, Nairobi, Kenya. 207 pp.

Marshall, G.A.K. 1936. Curculionidae (Col.) attacking cultivated plants. *Bulletin of Entomological Research* 27: 253-259.

Norman, J.C. 1972. Tropical leafy vegetables in Ghana. World Crops, July/August: 217.

Ogle, B.M. and Grivetti, L.E. 1985. Legacy of the chameleon: edible wild plants in the Kingdom of Swaziland, southern Africa. A cultural, ecological, nutritional study. 2. Demographics, species availability and dietary use, analysis by ecological zone. *Ecology of Food and Nutrition* 17(1): 1-30.

Pond, W.G. and Lehmann, J.W. 1989. Nutritive value of a vegetable *Amaranthus* cultivar for growing lambs. *Journal of Animal Science* 67(11): 3036-3039.

Ramanova, V.P. 1928. Injurious species of *Lixus* F. in the North Caucasian Region. *Bulletin of the North Caucasian Plant Protection Station* 4: 235-242.

Saunders, R.M. and Becker, R. 1983. *Amaranthus*: a potential food and feed resource. In: *Advances in Cereal Science and Technology*. Vol. VI. Pomeranz, Y. (Ed.), pp. 357-396. American Association of Cereal Chemists, St Paul, Minnesota.

Stallknecht, G.F. and Schulz-Schaeffer, J.R. 1991. Amaranth rediscovered. In: *Proceedings of the Second National Symposium on New Crops: Exploration, Research, and Commercialization*. Janick, J. and Simon, J.E. (Eds.), pp. 211-218. Purdue University, Indianopolis, Indiana.

Uzo, J.O. and Okorie, A.U. 1983. *Amaranthus hybridus*, a potential grain crop for West Africa. *Nutrition Reports International* 27(3): 519-524.

Van Tonder, J. 1993. Edible weed becomes life-saving crop. Farmer's Weekly, October: 44-46.

Weber, L.E., Applegate, W.W., Baltensperger, D.D., Irwin, M.D., Lehman, J.W. and Putnam, D.H. 1990. *Amaranth Grain* Production Guide. Rodale Press, Inc., Emmaus, Pennsylvania. 35 pp.

Whitbread, M.W. and Lea, J.D. 1982. Agronomy of *Amaranthus*. Unpublished report, Department of Crop Science, University of Natal. 10 pp.

Wilson, R.L. 1990. Insect and disease pests of *amaranthus*. In: *Proceedings of the Fourth National Amaranth Symposium: Perspectives on Production, Processing and Marketing*. Pages 163-169. University of Minnesota, St Paul, Minnesota.