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ARTHROPODS THAT STRESS WATERHYACINTH

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INTRODUCTION

Waterhyacinth is a problem largely because it: (1) blocks drainage and irrigation canals and interferes with fishing and water transportation; (2) is detrimental in causing excessive water loss through evapotranspiration (Brezny *et al.* 1973; Timmer and Weldon 1967); and (3) usurps water areas used for rice cultivation. Although herbicides will control the weed, the high rate of reproduction (Bock 1966) of the plant causes rapid reinfestation. A constant stress on the plant by a biological agent would therefore be helpful in reducing the reproductive capacity and also the abundance. As a result, a number of investigators (Benenett 1970; Bennett and Zwolfer 1968; Gordon and Coulson 1971; Silveira Guido 1965; Sankaran and Rao 1972; and myself (unpublished data) have made studies in South America, the United States, and India to determine what natural enemies of waterhyacinth, *Eichhornia crassipes* (Mart.) Solms (Pontederiaceae) may be potentially useful in the biological control of this weed.

Waterhyacinth is a problem in the southeastern United States, Africa, India, and Southeast Asia and occasionally in Central and South America. However, in certain areas of South America, the natural enemies reduce its vigor sufficiently to prevent the plant from becoming a serious problem (Perkins 1973). Also, in other countries, such as the United States, some native arthropods have been able to feed successfully on the introduced waterhyacinth. Indeed, one such arthropod, the mite, *Orthogalumna terebrantis* Wallwork, may have been accidentally introduced into the United States with the plant about 90 years ago.

POTENTIAL BIOLOGICAL CONTROL AGENTS

Damage resulting from attack on waterhyacinth by arthropods can occur in two ways by the direct removal of tissue and by the decomposition of tissue that surrounds the feeding area. If such damage is sufficiently severe, the reproduction of the plant may be slowed or halted. The biomass of waterhyacinth increases rapidly by the production of daughter plants when adequate nutrients are available and suppressants to growth are absent (Perkins 1973). Thus, reproduction by

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vegetative means greatly surpasses reproduction by seeds in any area where waterhyacinth is already established, though seeds are important in distribution of the plant to other areas (via the feet of waterbirds), and in survival during periods of extreme stress such as that caused by cold weather and herbicides. Since waterhyacinth is a pest mainly because of its rate of vegetative reproduction, a biological agent that suppresses this quality would be potentially effective. The stress produced would cause energy that might otherwise be channelled into the production of daughter plants to be redirected to the production of new tissue, which would limit the overall growth of the plant. Those biological agents responsible for direct removal of plant tissue can be divided into four categories: (1) defoliators and external leaf feeders, (2) petiole borers, (3) leaf tunnel producers and (4) scavenger species that enhance the effect of attack by other insects. Some holometabolous insects may fall into more than one category since the site of attack depends on the attacking stage.

(1) *Defoliators and external leaf feeders.* The most important of the arthropods that cause category (1) injury to waterhyacinth are species of grasshoppers, caterpillars and weevils.

The grasshopper genus *Cornops* (Acrididae) includes a number of species specifically associated with *Eichhornia* spp., *Cornops scudderi* Bruner in British Honduras, *C. longicorne* (Bruner) in Trinidad, and *C. aquaticum* (Bruner) in Uruguay and Argentina. All feed on species of *Eichhornia* and place their eggs into the petiole tissue of the plant. In Argentina, populations of *C. aquaticum* reached maximum levels of one nymph or adult per waterhyacinth plant in late summer. When such a population was present, most older leaves exhibited some damage, though little more than one-tenth of the overall foliage was consumed. Natural enemies of *Cornops* such as the weevil, *Ludovix fasciatus* (Gyllenhal), an unusual egg predator on this and the other species of *Cornops*, were responsible for limited damage by this grasshopper. The damage done by *Cornops* spp. to waterhyacinth is easy to recognize. Nymphs chew the leaf surface and leave large, irregular, whitish scars. Late-instar nymphs and adults chew large pieces from the leaves and leave ragged leaf fragments or sometimes bare petioles if the infestation is heavy.

In the United States, the grasshopper *Paroxya clavuliger* (Serville) (Acrididae) occasionally causes severe defoliation of waterhyacinth and has been known to remove more than one-tenth of the overall foliage in Sanford (Gordon and Coulson 1971) and near Eau Gallie, Florida. However, this species is not specific to waterhyacinth; it ranges from Ontario to the Gulf Coast (Blatchley 1920) and apparently feeds on various aquatic grasses and reeds.

Also, several lepidopteran larvae are potentially important defoliators of waterhyacinth; though, none restrict feeding to this plant. Thus, the most important of the defoliating caterpillars, *Palustra silveiraguidoi* Orfila, *P. tenuis* Berg, and

P. azollae Berg (Arctiidae), which all occur in South America, are commonly found on waterhyacinth or *Eichhorina azurea* (Swartz) Kunth, but they also feed on other plants. Therefore, they are not considered sufficiently host specific for use as biological control agents. Their damage is seen as large holes or sections missing from waterhyacinth leaves.

The waterhyacinth weevils, *Neochetina eichhorniae* Warner (1970) and *N. bruchi* Hustache (1926), feed externally on the leaves and petioles of waterhyacinth as adults. *N. eichhorniae* is apparently better favored by warmer weather and *N. bruchi* by cooler, though the two species have widely overlapping ranges and are found together in most field sites in Argentina. The adult weevil of either species chews numerous spots, approximately 2 mm in diameter, mainly on the upper surface of the leaves, but also on the underside of leaves and the upper petiole. One adult produces an average of about 20 feeding spots per day, and damage by five adults can kill a medium-sized waterhyacinth plant in the laboratory in about 10 days. However, feeding at the junction of the petiole and the leaf blade often kills the blade by cutting off the tissues of translocation, so the leaf is effectively eliminated though not consumed.

(2) *Petiole Borers.* Petiole borers, from the amount of damage produced per insect in a given time, are probably the most destructive to waterhyacinth of any arthropod.

The most important caterpillars that tunnel the petioles of waterhyacinth are: *Acigona infusella* (Walker) (Pyralidae), which has been reported from Uruguay, Argentina, Colombia, Trinidad, Brazil, Surinam, and Guyana (Bennett and Zwölfer 1968; Silveira Guido 1971); *Epipagis albiguttalis* (Warren) Pyralidae), a smaller caterpillar that occurs in Trinidad, Guyana, Surinam, Brazil (Bennett and Zwölfer 1968), Argentina and Uruguay (Silveira Guido 1965); and *Arzama densa* Walker (Noctuidae), which has been reported in the southeastern United States (Gordon and Coulson 1971; Vogel and Oliver 1969a, 1969b).

The damage produced by *A. infusella* and *A. densa* is similar. Usually, the larvae bore a tunnel in the petiole with the size depending on the size of the larva. Several petioles are attacked by a single larva during the larval period. Saprophytic fungi entering the damaged tissues subsequently increase the effect.

E. albiguttalis also produces a petiole tunnel, but this insect is smaller so it may make several tunnels in a single petiole, and several larvae may occur in the same petiole. The species tends to prefer smaller plants with enlarged petioles (Bennett and Zwölfer (1968).

Larvae of *N. eichhorniae* and of *N. bruchi* tunnel in the petioles, but they usually begin in the leaf blade or upper petiole and tunnel downward. A distinctive brownish line on the outside of the petiole is caused by decomposition of the tissues and indicates the location of the larva. Usually only one larva per petiole survives to reach the crown area of the plant, though as many as five larvae have occasionally been found in a single petiole. Young larvae may move from petiole to petiole, and the crown may contain eight or more late instar larvae that feed inside large blackened hollow areas. The overall effect of larval tunneling is to weaken the petioles so that they break or blacken and die as a result of fungus attack.

(3) *Leaf Tunnel Producers.* Among the arthropods reported to attack waterhyacinth, the waterhyacinth mite, *O. terebrantis* Wallwork (Galumnidae), is unique in producing leaf tunnels. The adult female mites, as they walk across a leaf blade, place individual eggs in separate laminae of the leaf blade, then the larvae emerge and begin tunneling under the leaf epidermis, usually away from the petiole. A mature leaf may bear more than 500 mite tunnels, and more than 20,000 mites may occur in a square meter of waterhyacinth (Perkins 1974). The sun often dries these tunneled leaves, which kills them and produces an effect similar to the initial symptoms of herbicide damage. This mite is specific to the Pontederiaceae, but it occurs occasionally on *Pontederia cordata* L. (Gordon and Coulson 1971).

(4) *Scavenger Species.* Several insect species are scavengers that enhance the effect of attack by other insects, but none of these are specific to waterhyacinth. It is therefore impossible to introduce them from another country as biological control agents; however, they already exist in many locations where waterhyacinth is found and may occasionally become significant because they enhance the stress on the weed. In Argentina, the most notable of scavenger species were large scarab beetles of the genera *Dyscinetus*, *Chalepides*, and *Cyclocephala*, several species of which produce similar damage on waterhyacinth. The adults have been found associated with large populations of *Neochetina* spp. larvae and adults in Argentina and *A. densa* in the United States. These insects will attack living plant material, but they are generally considered scavengers. They attack waterhyacinth by feeding inside the petioles or crown or feeding externally at the base of the petioles. At either site they deposit a mass of feces and decomposing plant tissue. Species identified from waterhyacinth are *Dyscinetus rugifrons* (Burmeister), *Dyscinetus* sp., and *Chalepides* sp. nr. *luridus* (Burmeister) from Uruguay (Silveira Guido 1965), *D. morator* (F.) from the United States, and *Cyclocephala* sp. from Argentina and Uruguay. Plants attacked by these species in Argentina often became putrid and were found to bear significantly fewer adult *Neochetina* spp.

OTHER ARTHROPODS THAT FEED ON WATERHYACINTH

Table 1 lists the arthropods discussed plus the other species which occur on waterhyacinth, the type of damage, the workers who have reported a species or worked with it, and the geographical areas from which they have been reported. In general, the "other arthropods" are not host specific to waterhyacinth or the

Pontederiaceae family and only occasionally occur on waterhyacinth. Although over 70 species are reported, the list is not definitive. New species are continually being added, and insects occurring on waterhyacinth in Asia and Africa have not been fully investigated.

Also, pathogens or opportunistic saprophytes are associated with the feeding damage of many of these listed arthropods. These insects that do infest the plant often open an entry for the pathogens, which then proceed to spread into living tissue adjacent to the feeding spot or tunnel. Thus, saprophytic organisms aid in the decomposition of the plant tissue and in the dispersal of nutrients and energy into the ecosystem where they can be used by other organisms.

TABLE 1

Arthropods associated with waterhyacinth
(*indicates species that stress severely)

Arthropoda	Type Damage[a]	Damaging stage[b]	Reported from (country)[c]	Reported by[d]
Orthoptera				
Acrididae: Catantopinae				
Cornops aquaticum (Bruner)	D	A, N	U, Ar	SG, P
Cornops sp.	D	A, N	G	Be-Z
**C. scudderi* Bruner	D	A, N	BH	Be
**C. longicorne* (Bruner)	D	A, N	T, S, B	Be, Be-Z
Opshomala marschalli (Bruner)	D	A, N	T	Be-Z
Tetrataenia phila Rehn	D	A, N	S, B	Be-Z
Paroxya clavuliger (Serville)	D	A, N	US	G-C, P
Acrididae: Cyrtacanthacridinae				
Schistocerca obscura (F.)	D	A, N	US	G-C, P
Acrididae: Acridinae				
Metaleptea brevicornis (L.)	D	A, N	US	G-C
Acrididae: Gomphocerinae				
Orphulella punctata (DeGeer)	D	A, N	J	Be
Dichromorpha viridis (Scudder)	D	A, N	US	G-C
Acrididae: Pyrgomorphinae				
Atractomorpha crenulata (F.)	D	L	I	S-R

TABLE 1 - *Contd.*

Arthropoda	Type Damage[a]	Damaging stage[b]	Reported from (country)[c]	Reported by[d]
Orthoptera				
Acrididae: Oxyinae				
Gesonula punctifrons Stal	D	L	I	S-R
Tettigoniidae				
Amblycorypha sp.	D	N	US	P
Conocephalus sp.	D (?)	A	US	G-C
Conocephalus fasciatus (DeG.)	D	A	US	P
Orchelimum agile (DeG.)	D ? O ?	A	US	G-C
Tettigoniidae sp.	D	A	SA	Be-Z
Gryllidae				
Argizala hebardi (Rehn)	R	A, N	U	SG
Blattellidae				
Neoblatella detersa (Walker)	?	A, N	J	Be
Blattidae				
Blattidae sp.	F	A	B	Be-Z
Hemiptera: Heteroptera				
Pentatomidae				
Mecocephala acuminata Dallas	S	A, N	U	SG
Miridae				
Miridae sp.	S	A	B	Be-Z
Hemiptera: Homoptera				
Cicadellidae				
Poeciloscarta victima (Germar)	S, O	A, N	U	SG
Draeculacephala inscripta Van Duzee	S	A	US	P
Dictyopharidae				
Taosa herbida (Walker)	S	A	T, S, B	Be-Z

TABLE 1 - *Contd.*

Arthropoda	Type Damage[a]	Damaging stage[b]	Reported from (country)[c]	Reported by[d]
Coccidae				
Coccidae spp.	S	A, N	S	Be-Z
			US	P
Aphididae				
Rhopalosiphum prob. *nymphaeae* (L.)	S	A, N	US	P
R. nymphaeae	S	A, N	I	S-R
Dermaptera				
Forficulidae				
Doru taeniatum (Dohrn)	Ca	A	US	P
Lepidoptera				
Pyralidae: Crambinae				
**Acigona infusella* (Walker)	TP	L	U, Ar	SG, P
			T,G,S,B,C	Be-Z
Pyralidae: Pyraustinae				
**Epipagis albiguttalis* (Warren)	TP	L	T,G,S,B	Be-Z
			U	SG
Samea multiplicalis (Guenée)	TP	L	US	P
			B	Be-Z
			T	Be
Hymenia perspectalis (Hübner)	D, EP	L	US	G-C
Pyralidae: Nymphulinae				
Synclita obliteralis (Walker)	EP, Ca	L	US	P
Nymphulinae sp.	D, Ca	L	US	G-C
Noctuidae				
**Arzama densa* Walker	TP	L	US	V-O, G-C
Spilosoma virginica (F.)	D	L	US	G-C
Spodoptera litura (F.)	D	L	I	S-R
Arctiidae				
Palustra silveiraguidoi Orfila	D	L	U	SG
P. tenuis Berg	D	L	U, Ar	SG
P. azollae Berg	D	L	U, Ar	SG

TABLE 1 - *Contd.*

Arthropoda	Type Damage[a]	Damaging stage[b]	Reported from (country)[c]	by[d]
Ecpantheria icasia (Cramer)	D	L	T	Be-Z
Diacrisia montana (Guérin-Méneville)	D	L	I	S-R
D. obliqua (Walker)	D	L	I	S-R
Tortricidae				
Tortricidae sp.	R	L	U	SG
Lepidoptera				
Lymantriidae				
Euproctis ochacantha Collenette	D	L	I	S-R
Pericallia ricini (F.)	D	L	I	S-R
Psychidae				
Mahasena graminivora Hampson	D	L	I	S-R
Coleoptera				
Curculionidae: Erirhininae: Bagoini				
Hyperodes ater Boheman	TP	L	U	SG
**Neochetina eichhorniae* Warner	TP	L	U, AR	SG, P
	D	A	T, SA	Be-Z
**N. bruchi* Hustache	TP	L	U, Ar	SG, P
	D	A	SA	Be-Z
Onychylis nigrirostris (Boheman)	D	A	US	Be, P, G-C
Onychylis spp.	D	A	Ar	P
Curculionidae: Otiorhynchinae				
Myllocerus dentifer (F.)	D	A	I	S-R
Curculionidae: Rhynchophorinae				
Sphenophorus pontederiae Chittenden	TP	A, L	US	Be, G-C
Melyridae: Malachiinae				
Apolochrus fasciatus (F.)	D	A	I	S-R

TABLE 1 - *Contd.*

Arthropoda	Type Damage[a]	Damaging stage[b]	Reported from (country)[c]	Reported by[d]
Coleoptera				
Scarabaeidae				
**Dyscinetus* sp.	TP, Sc	A	U	SG
**D. rugifrons* (Burmeister)	TP, Sc	A	U	SG
**D. morator* (F.)	TP, Sc	A	US	P
**Cyclocephala* sp.	TP, Sc	A	U, Ar	SG, P
Chalepides luridus (Burmeister)	TP	L	U	SG
Chalepides barbata barbata (F.)	TP	L	U	SG
**C.* sp. nr. *luridus* (Burmeister)	TP, Sc	A	U	SG
Carabidae				
Carabidae sp.	F	A	U, Ar	SG, P
Diptera				
Ephydridae				
Hydrellia sp.	TP	L	U	SG
			B, G, BH	Be-Z, Be
Chloropidae				
Eugaurax n. sp.	TP	L	G, S, B	Be-Z
Polyodaspis sp.	TP	L	I	S-R
Chironomidae				
Chironomidae spp.	TP	L	S, B, Ar	Be-Z
			U	SG
			Ar	P
Chironomus flavipilus Rempel	TP	L	B	Be-Z
Endochironomus sp.	TP	L	I	S-R
Dolichopodidae				
Thripticus sp.	TP	L	G, S, B	Be-Z
Syrphidae				
Eristalis agrorum (F.)	Sc?	L	US	P
Stratiomyidae				
Odontomyia sp.	Sc?	L	US	P

TABLE 1 - *Contd.*

Arthropoda	Type Damage[a]	Damaging stage[b]	Reported from (country)[c]	Reported by[d]
Acarina				
Oribatei: Galumnidae				
Orthogalumna terebrantis Wallwork	TL	L, N	US	Be, G-C, P
			U, Ar	SG, P
			B, G, S	Be-Z
			J	Be
Tetranychidae				
Tetranychus cinnabarinus (Boisduval)	S	L, N, A	U	SG
			G, S, B	Be-Z
T. tumidus Banks	S	L, N, A	US	G-C, P
T. gloveri Banks	S	L, N, A	US	G-C
Tetranychus sp.	S	L, N, A	J	Be
Eriophyidae				
Eriophyidae sp.	S	L, N, A	U	SG

a Damage: Ca—builds case or shelter with leaves; D—defoliates or feeds externally on leaves; EP—external feeding on petiole; F—feeds on flowers; O—damage caused by oviposition; R—consumes roots; S—sucks plant juices; Sc—scavenger; TL—tunnels leaves; TP—tunnels petioles.

b Stage: A—adult; L—larva; N—nymph.

c Country: Ar—Argentina; B—Brazil; BH—British Honduras; C—Colombia; G—Guyana; I—India; J—Jamaica; P—Paraguay; SA—South America in general; S—Surinam; T—Trinidad; U—Uruguay; US—United States of America.

d Worker reporting species: Be—Bennett, 1970; Be-Z—Bennett and Zwölfer 1968; G-C—Gordon and Coulson 1971; P—Perkins 1973 and 1974 and unpublished data; S-R—Sankaran and Rao 1972; SG—Silveira Guido, unpublished data 1965; V-O—Vogel and Oliver 1969a and b. The symbol for each investigator is in line with the symbol for the country where he found or studied the arthropod.

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