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The Potential of *Parapoynx stratiotata* L. as a Biological Control Agent for Eurasian Watermilfoil

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ABSTRACT

The aquatic larvae of the European moth *Parapoynx stratiotata* L. (Lepidoptera: Pyralidae) have been considered for biological control of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in the U.S.A. Field investigations near Latina, Italy and laboratory tests in Rome were conducted during the summer of 1977 to determine the host range of this species. *P. stratiotata* larvae were common on Eurasian watermilfoil, but were often equally or more abundant on elodea (*Elodea canadensis* Mich.), and coontail (*Ceratophyllum demersum* L.) and occurred less commonly on whorled watermilfoil (*Myriophyllum verticillatum* L.) and occasionally on a narrow-leaved *Potamogeton* sp., spiny naiad (*Najas marina* L.), and *Callitriche* sp. Newly-hatched larvae developed to last instars on 11 of 13 aquatic plant species tested in the laboratory. Medium-size larvae collected from Eurasian watermilfoil and transferred to floating-leaf pondweed (*Potamogeton natans* L.), curlyleaf pondweed (*P. crispus* L.), *P. lucens L.*, the narrow-leaved *Potamogeton* sp., coontail, whorled watermilfoil, spiny naiad, and *Najas minor* L. fed actively indicating that larvae could switch to other hosts if Eurasian watermilfoil became unavailable. Larvae constructed cases from star duckweed (*Lemna trisulca* L.) but did not feed on it or *Vallisneria* sp. Discrepancies in feeding preferences between these studies and previous reports from other countries indicate that biotypes of *P. stratiotata* probably exist. Further investigations on biotypes should be conducted before this insect is further considered for introduction into the U.S. for biocontrol of Eurasian watermilfoil.

INTRODUCTION

Eurasian watermilfoil is a serious submersed aquatic weed in many areas of the U.S. and Canada. It is considered to be native to Europe and parts of Asia. Herbicides are expensive and provide only temporary control. Since Eurasian watermilfoil is an introduced plant, it has been considered a likely candidate for biological control. Projects were therefore initiated in both Pakistan and Yugoslavia to study insects attacking this weed (16) and about 25 species of insects were found to feed on it. Eleven insects were reported in Pakistan (3) while 15 species were reported from Yugoslavia (8, 9). Among the most promising species was a European pyralid *P. stratiotata.*

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The larva of *P. stratiotata* has been described by Hasenfuss (4) and he provided a key to separate it from other known European Nymphulinae larvae. The larvae are up to 25 mm long and are characterized by the presence of branched gills (Figure 1). The adult has a wing span of 20 to 25 mm. The forewings are light brown and the hindwings are creamy white with a single brown band with a pronounced angle (Figure 2). The band may be interrupted or obscure in some specimens. The Pyralidae-Nymphulinae section in Klima (7) includes references on *P. stratiotata* and related aquatic pyralids.

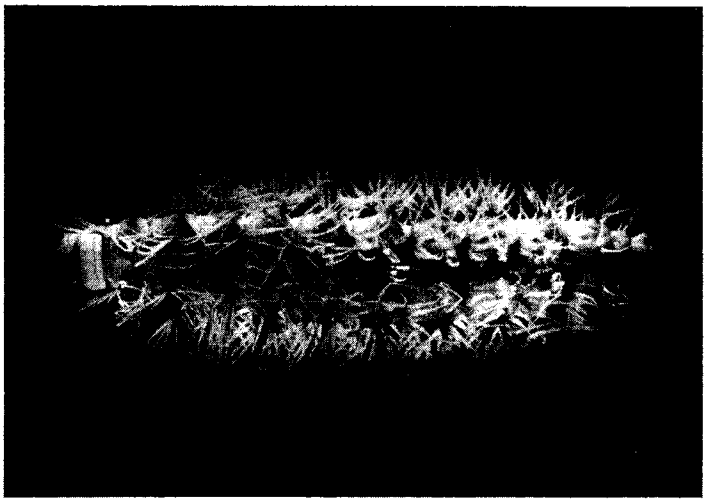

Figure 1. Mature larva of *Parapoynx stratiotata* showing profusion of branched gills characteristic of this genus, length—25 mm.

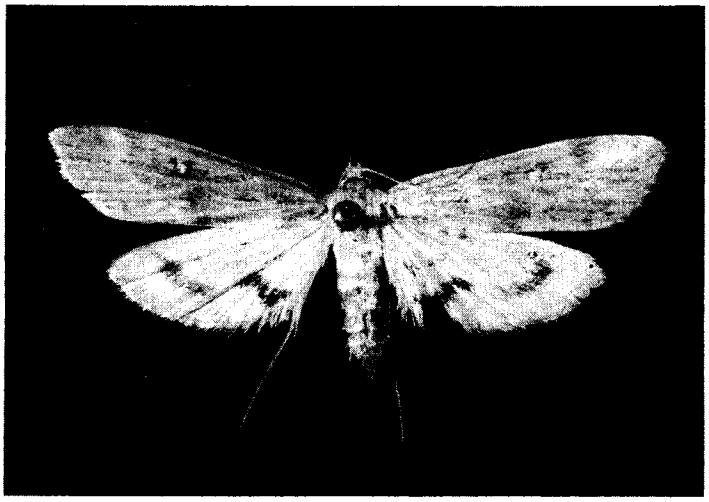

Figure 2. Adult *Parapoynx stratiotata* with wing spread of 22 mm.

In Yugoslavia, Lekic (8) found that *P. stratiotata* fed in nature most often on Eurasian watermilfoil, less so on whorled watermilfoil and water aloe (*Stratiotes aloides* L.), and occasionally on coontail. However, under experimental conditions, the larvae were reared on waterchestnut (*Trapa natans* L.), *Potamogeton lucens* L., European frogbit (*Hydrocharis morsusranae* L.), common duckweed (*Lemna minor* L.), *Najas minor* All., *Salvinia natans* All., and *Utricularia neglecta* Lehm. Caterpillars placed into aquaria containing all these plant species in a free choice situation, fed only on Eurasian watermilfoil (90%), whorled watermilfoil (8%) and water aloe (2%) (8). This report increased interest in the potential use of *P. stratiotata* for biological control of Eurasian watermilfoil in the United States.

In Russia (1, 6), *P. stratiotata* larvae overwintered but did not feed in beds of elodea and pondweeds. In spring, these larvae fed on elodea until *Potamogeton lucens* appeared, which they fed upon until they pupated. Young larvae hatching in summer also fed on *P. lucens* and they sometimes fed as heavily on coontail. Kashkin (6) concluded that the larvae on coontail had switched from *P. lucens* which was the only plant that reached the water surface and was therefore available to the female for oviposition. In autumn, as the *P. lucens* died, the larvae gradually moved to floating leaves of *Nymphaea* sp., water smartweed (*Polygonum amphibium* L.), broadleaf pondweed, etc., and into beds of *Isoetes lacustris* and *Chara* sp., all plants on which they never occurred during the summer. He concluded that *P. lucens* and to a lesser extent coontail were the two true food plants in the Yakhromskoe Reservoir with elodea being fed on only in spring before *P. lucens* appeared. In Kashkins food selection chambers, the larvae preferred *P. lucens*, followed by coontail, elodea, and *Chara* sp. In some tests, larvae moved from the *Chara* sp. chambers. When they were given only *Chara* sp., they consumed considerable quantities although Kashkin did not indicate whether the larvae were able to complete development on it. In quantitative tests, the larvae consumed more coontail even though *P. lucens* was preferred in chamber tests and in the reservoir. In fact, *P. stratiotata* larvae consumed equal amounts of elodea and *P. lucens* (6).

Urban (17) studied the leaf mining fauna of four species of aquatic plants in Poland and reported that *P. stratiotata* and *Acentria* (=*Acentropus*) *nivea* (Olivier) mined in the stems and leaves of *P. lucens* and *P. perfoliatus* mainly in autumn as well as in the stems of elodea and Eurasian watermilfoil.

Soszka (14), also working in Poland, found Lepidoptera to be scarce among the invertebrate fauna on aquatic plants. He found that Lepidoptera larvae were more common on elodea than on pondweeds and the two most abundant species of Lepidoptera were *A. nivea* and *P. stratiotata*. In addition, he concluded that Eurasian watermilfoil had less variety of invertebrate fauna than elodea. He later reported (15) that the feeding intensity of Lepidoptera larvae was several hundred times higher than for other invertebrates inhabiting aquatic plants. He reported that both *P. stratiotata* and *A. nivea* built cases of pondweed leaves. The mining stage (early instars) of these two species occurred mainly in the autumn in petioles of *P. perfoliatus* and *P. lucens*. Examination of food composition in the alimentary tracts of *P. stratiotata* and *A. nivea* revealed that these species fed primarily on vascular plants. Fragments of pondweed and elodea were identified along with small amounts of detritus, calcium deposits, and animal remains (*Cladocera, Oligochaeta* and *Rotatoria*). He concluded that invertebrates utilized Eurasian watermilfoil much less than pondweeds for food and mining.

In Germany, *P. stratiotata* was found on *P. lucens* and *P. perfoliatus* by Muller-Liebenau (13). Other aquatic plants reported as hosts for *P. stratiotata* larvae included water aloe and waterchestnut (5); *Alisma plantago-aquatica* L., *Callitriche verna* L., and European white waterlily (*Nymphaea alba* L.) (10).

In the United States, McGaha (11, 12) reported that *Parapoynx* (=*Nymphula*) *badiusalis* (Walker) fed on Northern watermilfoil (*Myriophyllum exalbescens* Fernald), a plant closely related to Eurasian watermilfoil and often confused with it.

Balciunas (personal communication) has collected *Synclita obliteralis* (Walker) larvae on Eurasian watermilfoil in Louisiana and Florida. Spencer and Lekic (16) reported *Parapoynx allionealis* (Walker) feeding on Eurasian watermilfoil in Florida. The same *Parapoynx* species was also reared from broadleaf watermilfoil, *Myriophyllum heterophyllum* Michx. (2), and parrotfeather *M. aquaticum* (Vellozo) Verdc. (Habeck, unpublished). Other aquatic Pyralidae feeding on milfoils in Florida include *Parapoynx obscuralis* (Grote) on parrotfeather and *Synclita obliteralis* (Walker) on parrotfeather and broadleaf milfoil (Habeck, unpublished).

METHODS AND MATERIALS

Laboratory investigations were conducted at the USDA Biological Control of Weeds Laboratory in Rome, Italy during the summer of 1977. Most of the field work was done near Latina about 70 kilometers south of Rome. Latina is in the center of a rich agricultural area producing a diversity of crops ranging from artichokes and tomatoes to corn and sugar-beets. This area was a swampy marshland until it was drained during Mussolini's reign. Numerous canals of various sizes provide water for irrigation and for filling spray tanks. Aquatic weeds abound in these canals and weed control was never observed other than a boat mounted mower which was able to operate only in the larger canals. The wide variety of weeds in the canals provided an opportunity to observe the host plants of *P. stratiotata* under natural conditions. Larvae were associated with their host plants by checking the plants individually in the field or by sorting the plant species into plastic bags and then carefully inspecting them in the laboratory.

An experiment to determine the suitability of various aquatic plants for development of *P. stratiotata* larvae was conducted in the Rome laboratory. Ten newly-hatched larvae were placed together in plastic petri dishes (100 mm diam. x 10 mm deep) along with leaves and/or stems of aquatic plants. Thirteen different plants species were tested including broadleaf pondweed, *P. perfoliatus, P. lucens,* curly-leaf pondweed, Eurasian watermilfoil, whorled water-

milfoil, coontail, elodea, spiny naiad, European frogbit, *Callitriche* sp., *Lemna* sp., and an unidentified algae with three replications for each plant species. Larvae were obtained from eggs of reared or field collected females. The larvae were checked for mortality three times weekly and those remaining alive were transferred to clean petri dishes with fresh plant material. All tests were started July 6 except the algae, whorled watermilfoil, and a second series of Eurasian watermilfoil started on July 15, and *P. lucens* on August 3. All tests were terminated September 15.

Another experiment was initiated August 9 to determine whether larvae of *P. stratiotata* could switch from Eurasian watermilfoil to other food plants. Five medium-size larvae (collected from Eurasian watermilfoil in canals near Latina) were transferred individually to petri dishes, each containing leaves and/or stems of an aquatic plant species. Fresh plant material was added as needed and the water was changed at least every other day. At the end of 10 days, the experiment was terminated. The following plants were tested: broadleaf pondweed, curlyleaf pondweed, *P. lucens,* a narrow-leaved *Potamogeton* sp., coontail, whorled watermilfoil, spiny naiad, *N. minor,* star duckweed, and *Vallisneria* sp.

RESULTS AND DISCUSSION

Larvae were commonly found on Eurasian watermilfoil at many locations, but they were often equally abundant or more abundant on elodea and coontail. They were found less commonly on whorled watermilfoil and occasionally on the narrow-leaved *Potamogeton* sp., spiny naiad and *Callitriche* sp. A few prepupae and a pupa were also found on *Polygonum* sp. One larvae was found in a case made of *Vallisneria* sp., but larvae were never found feeding on *Vallisneria* sp. In these studies *P. stratiotata* larvae naturally fed on six to eight plant species besides Eurasian watermilfoil. Broadleaf pondweed and *Nymphaea* sp., both reported as hosts by Kashkin (6) and European frogbit were common in the canals and were checked many times but the only lepidopterous larvae found on these aquatic plant species were those of *Nymphula nymphaeata* L. No *P. stratiotata* larvae were found on *P. lucens*, a host reported by both Kashkin (6) and Urban (17). Two other reported host plants, water aloe and water chestnut, were not observed in the canals.

The laboratory tests of development of *P. stratiotata* on 13 aquatic plant species indicated that *Lemna* sp. and the algae were not suitable hosts since all the larvae were dead within seven days, with little or no feeding observed on either species. On European frogbit, 26 of 30 larvae were dead within five days, but at the end of the experiment two mature larvae were alive and one adult had emerged. Larvae fed on broadleaf pondweed but more than half died within two weeks and only six were alive after 29 days. Five were alive at the end of the experiment and one adult had emerged. Survival was better on the other plants but only one adult was obtained (from *P. perfoliatus*). Larvae fed readily on all of these plants and at the end of the experiment 37.5% of those alive were pre-pupae or pupae. The failure to obtain adults from these other plant species (including Eurasian watermilfoil) was probably due to the small containers used for rearing and the constant disruption in transferring the larvae to fresh containers every two or three days. Many larvae were disturbed just prior to, during, or just after moulting, a particularly vulnerable period in their life cycle, especially for mature larvae in the process of pupating. Another possible cause of mortality of the larvae was the deterioration of the leaves (especially broadleaf pondweed and European frogbit) after two or three days which badly contaminated the water. Despite the failure to rear many larvae to the adult stage, this experiment demonstrates that in the laboratory, many aquatic plant species are acceptable as hosts, a conclusion also reached by Lekic (8) who reared this species on a wide variety of plants in the laboratory.

In the laboratory experiment where *P. stratiotata* larvae were transferred from Eurasian watermilfoil to 10 other aquatic plant species, larvae fed on the following plants after transferral: broadleaf pondweed, curlyleaf pondweed, *P. lucens,* a narrow-leaved *Potamogeton* sp., coontail, whorled watermilfoil, spiny naiad, and *N. minor.* Larvae constructed cases of star duckweed but did not feed on it or *Vallisneria* sp.

On numerous occasions, *P. stratiotata* eggs were found on the underside of the floating portion of *Vallisneria* sp. leaves and Lekic (8) reported the female laid eggs mostly on the underside of European frogbit (a non-host) and Eurasian watermilfoil leaves. Since moths lay eggs on non-host plants, oviposition preference tests appear to be meaningless for this species.

While the differences in laboratory results may be due to different techniques, the discrepancy in results of field observations on the natural food plants of *P. stratiotata* in Yugoslavia, Russia, Germany, and Italy (Table 1). is not easily explained. The field differences may be attributed in part to difference in the distribution of the plant species. For example, water aloe and waterchestnut, both reported as hosts in Yugoslavia (8) were not observed in the Latina area of Italy.

The possibility of misidentification of *P. stratiotata* is

TABLE 1. SOME NATURAL HOSTS OF *Parapoynx stratiotata* IN SEVERAL EUROPEAN COUNTRIES.

	Area and References			
Host Plants	Germany France Belgium 4,5,10,13	Italy	Russia 1,6	Yugo-slavia 8,9
Eurasian watermilfoil *Myriophyllum spicatum*		X		X
Whorled watermilfoil *Myriophyllum verticillatum*		X		X
Coontail *Ceratophyluum demersum*		X	X	X
Pondweeds *Potamogeton lucens*	X		X	
Potamogeton perfoliatus	X			
Elodea *Elodea canadensis*		X	X	
Water Aloe *Stratiotes aloides*	X			X
Water chestnut *Trapa natans*	X			

unlikely. It is a well known species in Europe and should not be readily confused with any other species in the adult stage. However, *Parapoynx* larvae are all very similar and rarely separable in the field. Lekic and Mihajlovic (9) recorded *P. nivalis* Denis & Schiffermuller from Eurasian watermilfoil but considered it as accidental. Another species, *Nymphula* (probably = *Parapoynx*) *amanica* Osth. is very similar to *P. stratiotata* and occurs in the Middle East and its distribution may extend into Russia.

The most likely explanation for the discrepancy in host-preferences in nature is the presence of biotypes of *P. stratiotata* with each biotype feeding on certain plants or groups of plants. This hypothesis can only be proven or disproven with a considerable amount of research comparing larvae from various areas under similar conditions. As indicated by Lekic (8) and Kashkin (6), and further substantiated by these observations in Italy, the larvae tend to feed on a wide variety of plants in laboratory non-choice tests. It is imperative that biotype studies be carried out under simulated field conditions with larvae being given a choice among a wide variety of plants. Investigations to determine the proportion of plant species in the diet relative to the proportional abundance of the plant in the field are also needed. If biotypes of *P. stratiotata* do exist, then further biocontrol investigations should be concentrated on those specific to Eurasian watermilfoil. Introduction of *P. stratiotata* from the Latina area into the United States is not recommended since the larvae are polyphagous.

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