PHYTOPHAGOUS INSECTS OBSERVED ON WATERMILFOIL, *MYRIOPHYLLUM SPICATUM* L., IN YUGOSLAVIA IN 1967-1968*

M.B. LEKIC

In Yugoslavia there are reports from the mid-19th century of three plant species of the genus *Myriophyllum* L.: *M. spicatum* L., *M. verticillatum* L. and *M. alterniflorum* DC (Farkas - Vukotic, 1869). According to Stankovic (1962), *Myriophyllum* is found in Lake Ohrid in Macedonia where it generally grows in the 3 - 7 metres deep submersion zone.

Myriophyllum occurs in many of the stagnant and slow-running waters of Yugoslavia, e.g., navigable canals, irrigation and drainage ditches, fish-ponds and lakes, creating an important problem for the normal flow of water, navigation and fishing. The plant has a very rapid vegetative growth and quickly spreads through the water-ways. This, together with the fact that it grows from altitudes of 60 to over 950 m and in water 0.5 to over 4 m deep, creates a wide-spread economic problem.

It is impossible to control these, or any other aquatic plants, by means of chemicals because of the high costs involved and the danger of poisoning fish, game and even domestic animals. It would, therefore, be desirable to propagate and establish natural enemies such as phytophagous insects.

Methods

All research on phenology, ethology, ecology and population problems was carried out simultaneously at certain pre-selected localities in the open and in special, large aquaria kept under various conditions.

Particular attention was given to the host-specificity of the insect species. The amount of food necessary for the development of an individual or group of individuals has been determined (Lekic, 1968).

Some important phytophagous insect species living on *M. spicatum*

In the areas investigated, *M. spicatum* frequently

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developed in association with *Ceratophyllum* spp. (*C. demersum* L. and *C. submersum* L.) and mainly in stagnant and slow-running waters. These are specific, ecological environments in which the biocoenotic relations develop more or less spontaneously. In such communities, several species of phytophagous insects have been observed on *M. spicatum*, and those showing an exclusive or great dependence on this host plant have been selected for further phenological, ethological and population dynamics studies.

So far, three species of Pyraustidae Meyrick (subfam. Nymphulinae Duponchel, Lepidoptera) and one Acentropid have been found as larvae on *M. spicatum*:

Parapoynx stratiotata L. (Pyraustidae),

Cataclysta lemnata L. (Pyraustidae),

Nausinoe nymphaeata L. (Pyraustidae),

Acentropus niveus Oliv. (Acentropidae)

These only live in fresh water in Europe.

Starvation tests carried out in the laboratory have shown that *P. stratiotata* is almost host-specific to *M. spicatum* in this area. In aquaria containing different species of aquatic plants the larvae fed only on *M. spicatum*, but in aquaria with only one plant species they also fed on *Ceratophyllum* spp., on which, however, they were unable to complete development. Aquatic plants belonging to the genus *Stratiotes* L., to which *P. stratiotata* probably owes its name, are not found in the irrigation and drainage ditches in the areas investigated. Consequently, *M. spicatum* remains its primary host-plant.

P. stratiotata has a very high reproductive potential, thus facilitating mass rearings. Natural populations, however, are to some extent reduced by some predators, especially the larger dragon-flies.

C. lemnata and *N. nympheata* feed on *M. spicatum* and some other aquatic plants such as *Hydrocharis* spp., *Lemna* spp. and *Potamogeton* spp. They feed on *M. spicatum* to a depth of about 10 cm from the water surface (rarely deeper), affecting growth and flowering.

M. spicatum is the primary host of *A. niveus* which is a less effective control agent than *P. stratiotata*.

During investigations into the hibernation sites of *P. stratiotata* larvae, an interesting experiment was

carried out. Under natural conditions, before winter frosts set in, larvae descend to the lower parts of the host-plant, i.e. to the deeper layers of water, and remain there, on or within the stalks or in the webbed leaves, until the following spring when they leave their hibernation sites to continue normal feeding and development. Experimental populations had to be maintained over winter in the aquaria and presented a problem because of the shortage of food material. On December 15, 1968, several thousand larvae were transferred to special plastic containers and exposed to low temperatures (up to -17°C). All the water in the containers was frozen solid so that the larvae were preserved in pure ice. In mid-January several containers were allowed to thaw out, the larvae were replaced in the aquaria with *M. spicatum* and kept at 15-18°C. These larvae displayed normal behaviour and started to move and feed. Other larvae will be thawed out when thawing takes place naturally in the canals and ditches from which they came.

The practical importance of this experiment is that it is possible to maintain experimental populations over winter; larvae can be kept in this condition for longer periods and may even be transported thus to other areas or countries.

Some Curculionids (Coleoptera) are also important control agents of *M. spicatum*, the more important being *Litodactylus leucogaster* Marsh (= *myriophylli* Gill.) and *Eubrichius velutus* Beck. Adults of the former feed mainly on the floral parts above the surface and only occasionally descend into the water. Adults of the latter generally live in the water and feed on the leaves and stalks of *M. spicatum*. The larvae of both species live on the stalks, which are under water, or on the inflorescences, which are partly submerged and partly above water. In some localities, *L. leucogaster* achieves very high populations and appears to be the dominant Curculionid in all localities.

Two Curculionids belonging to the genus *Bagous* have been observed on *M. spicatum* living similarly to the above mentioned species, but occur in small numbers only. Curculionids do not reach even 10% of the control power of the larvae of *P. stratiotata*.

The degree to which aquatic insects are phytophagous

Host-specificity of aquatic insect species such as *P. stratiotata* is not so important as that of those living

on dry land. This is due to the fact that practically all aquatic plants in irrigation and drainage ditches are noxious and their control, in any measure, is consequently useful. It is, therefore, not dangerous if an insect species moves from one aquatic plant to another.

Based on several years' observations it may be stated that it is no longer possible to talk of strictly monophagous insect species. If such species actually exist at present, they are, undoubtedly, quite able to adapt themselves, under critical situations, to related plant species. If a very few individuals of a population were to survive the critical starvation phase, i.e. the few first generations, a new population of still greater vitality would become established on the new host-plant and after several generations they would not even return to the original host-plant.

Such phenomena are being witnessed almost daily in nature, for, at every step, new pests of cultured plants appear, which, until now, lived on some related or even unrelated weed species.

In addition to the necessary preliminary experiments, newly introduced phytophagous insects must be kept under constant observation; to examine their population behaviour under the new ecological conditions so that adequate measures may be taken, should they become adapted to new plant species, especially any cultivated ones.

Conclusions

Of the phytophagous insects studied, *P. stratiotata* has proved to be the most effective control agent of *M. spicatum*. In the areas investigated *M. spicatum* is the primary host-plant of this insect. The larvae are adapted to live in water and are unable to maintain themselves outside this medium. Mass rearings of *P. stratiotata* may be undertaken.

Other Lepidoptera species observed were poor control agents of *M. spicatum*.

The Curculionid species to some extent controlled the growth and seed-formation of *M. spicatum*.

References

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