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Problems and Control of Aquatic Weeds in the Irrigation Systems of Thailand

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ABSTRACT

The aquatic plants which cause problems in the extensive irrigation systems of Thailand are usually the exotic species which find conditions in the irrigation channels favorable for growth and proliferation. The most troublesome weeds, as well as some of the control methods used in Thailand, is discussed in this paper.

Key Words: Mimosa, Hydrilla, Potamogeton, Salvinia, Eichhornia, chemical control, biological control.

INTRODUCTION

Thailand is one of the Southeast Asian countries in the tropical part of the world, located between latitude 6 and 20 degrees north and longitude 98 and 106 degree east. The land area is 51.4 million hectares, of which 23.6 million hectares are farmed. Only 3.32 million hectares are irrigated. All the irrigation and drainage work in Thailand is under the direction and responsibility of the Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperative.

To provide a proper water control system to the irrigable area, many irrigation structures have been constructed. For example a diversion dam on the main river, Chao Phraya, at Chainat forms a distribution canal system to supply water to paddy fields and many other agricultural purposes. These constructions affected the aquatic ecosystem, often adversely by providing excellent habitat or by stimulating weed growth. The explosive growth of aquatic plants, especially introduced plants, create problems involved with practically all water uses in Thailand.

A recent survey by the aquatic group of the Weed Control and Research Branch, RID, showed that more than 10% of the water area maintained by the Royal Irrigation Department suffers from serious weed problems and requires regular weed control.

REGIONAL WEED PROBLEMS

Thailand is approximately 1800 and 800 km north to south and east to west, respectively. This large size and the existence of tropical lowlands, as well as mountainous regions, allows the division of the country into four physiographic regions (Figure 1). The aquatic plants which cause problems in each of these regions are described below.

Northern

The northern region is also the mountainous region of the country with elevations of up to 2600 meters above sea level. Irrigation and hydroelectric reservoirs as well as natural lakes are commonly found in this area. Four relatively flat basins are the origin of four major tributaries of the Chao Phraya, Thailand's major river system. These tributaries are the Ping, Wang, Yom and Nan rivers, all of which seasonally flood and thus have a flood plain particularly conducive to the growth of the exotic *Mimosa pigra* L. This species is the most serious weed problem in and along all types of waterways in this region[2]. It is estimated that not less than 10,000 ha of land, mostly adjacent to water bodies, are now infested with *Mimosa pigra. Eichhornia crassipes* (Mart.) Solms, *Hydrilla verticillata* (L.F.) Royle and

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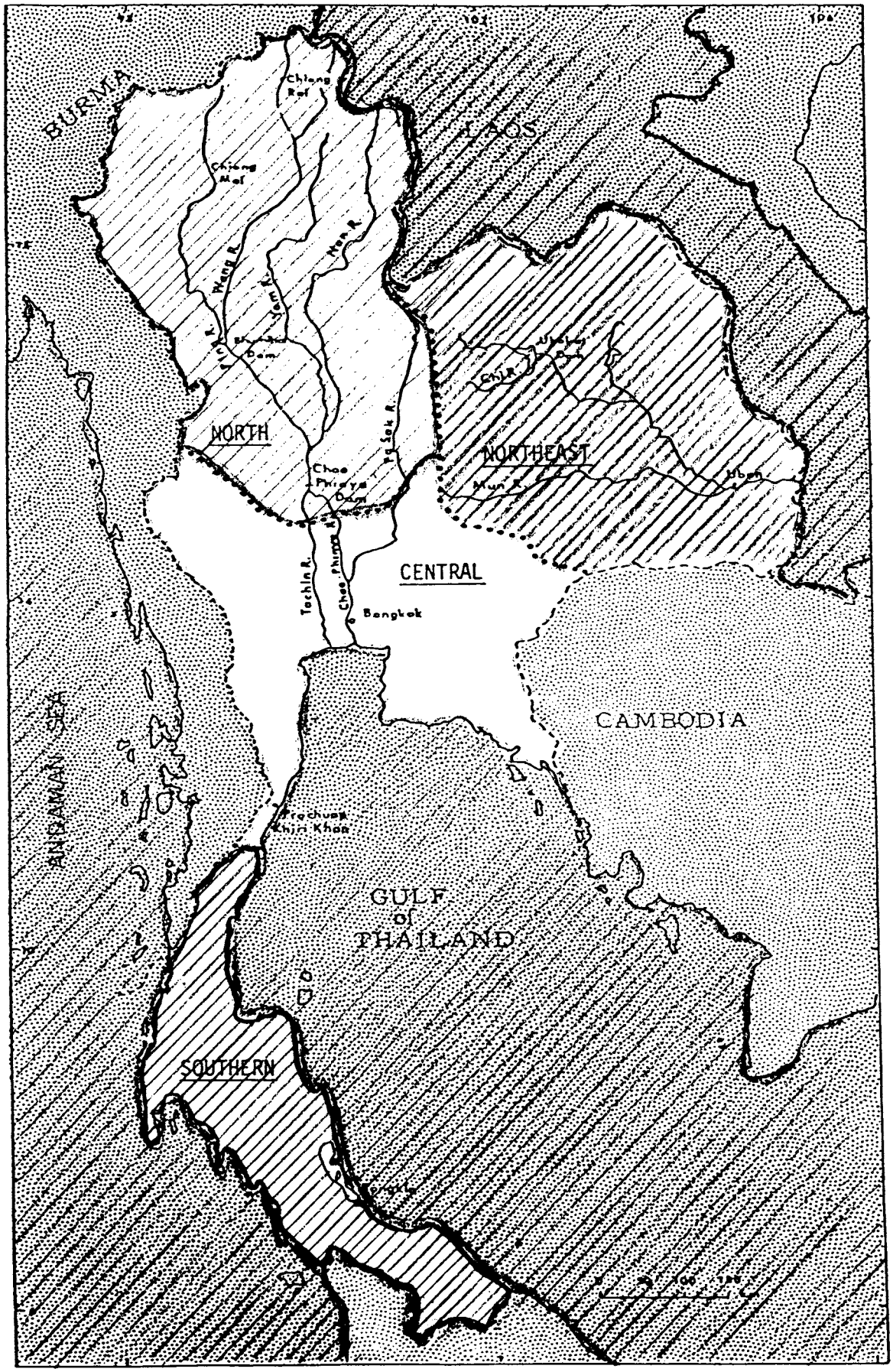
[2]Allen, G. E. *et al.* 1977. Report on Short Course on the Control of Aquatic Weeds and an Assessment of their Economic Significance in Thailand. International Plant Protection Centre, Oregon State University, Corvallis, 73 p.


BURMA
LAOS
CAMBODIA
NORTH
NORTHEAST
CENTRAL
SOUTHERN
Bangkok
Chiang Rai
Chiang Mai
Ping R.
Wang R.
Yom R.
Nan R.
Sirikit Dam
Pasak R.
Chao Phraya Dam
Mun R.
Ubon
Tachin R.
Chao Phraya R.
Prachuap Khiri Khan
Songkla
ANDAMAN SEA
GULF of THAILAND

Najas graminea Dilile are also significant problems in several waterways where the habitat is conducive to their growth.

Central

The soils of the central plains are primarily rich flat alluvial soils which form the "rice bowl" of Thailand. Irrigation water for this agricultural area is provided by the Chao Phraya project, the largest irrigation project in Thailand, which covers approximately 910,000 ha of land. The water supply for this area, in addition to the Chao Phraya, are the Nan, Ping, Yom, Wang and Pasak rivers.

Eichhornia crassipes is an acute problem in the Chao Phraya Project. This weed is present throughout the year in the canals and many rivers. It is estimated that more than 2,000 hectares of water area in this region are covered with *E. crassipes*. During the rainy season (July-November) *E. crassipes* also infests the canals down to the North and South Rangsit Canal.

The most common emergent hydrophytes are *Coix aquatica* Roxb., *Colocasia esculenta* (L.) Shott, and *Polygonum tomentosum* Willd. Submersed weeds, *hydrilla, Najas* and *Ceratophyllum demersum* L. are present in the region, but turbid water limits their growth to some extent. In 1984, *Typha latifolia* L. began to be a problem in the Petchburi region.

Northeastern

The northeastern region is dominated by the barren, relatively dry Korat plateau. The soils of this region consist of fine loams which are relatively low in nutrients and occasionally saline.

Due to the uneven and lower annual rainfall in this region, over 500 irrigation tanks (small man-made reservoirs) and related irrigation distribution systems have been constructed in this area. Some major irrigation reservoirs and hydroelectric projects have also been developed.

Aquatic weeds in this area are greater in number (more diverse) and include: *Eichhornia, Hydrilla,* and *Najas* as mentioned before, as well as *Salvinia cucullata* Roxb. ex. Pory, *Potamogeton malainus* Miquel, *Eleocharis dulcis* (Burm f.) *Chara zeylanica* K.L. ex. Willd. and *Nymphea lotus. Salvinia* is a major problems in the tanks and *Potamogeton* and *Hydrilla* are particularly troublesome in the irrigation canals, most often in the dry season when water in the canals are relatively clear, thus permitting growth of the submersed species.

Southern

This region extends many km down the Malay peninsula and is dominated by north-south oriented low mountain regions. *Hydrilla* and *Potamogeton* (as above) are seriously infesting regional irrigation canals, particularly in the Duson and Klongwad irrigation projects. *Eichhornia* is also a problem in several areas.

TABLE 1. THE MOST ABUNDANT AQUATIC WEEDS PRESENT IN THE IRRIGATION SYSTEMS OF THE FOUR PHYSIOGRAPHIC REGIONS OF THAILAND. E = EXOTIC, N = NATIVE, C = CENTRAL, NE = NORTHEAST, N = NORTHERN AND S = SOUTHERN.

Plant Species[1]	Origin	Region	Water Types
1. *Eichhornia crasspies*	E	All	canals, rivers, lakes
2. *Mimosa pigra*	E	N,C	canals, lakes, rivers
3. *Hydrilla verticillata*	E	N,NE,S	lakes, canals
4. *Potamogeton malainus*	E	NE,S,C	canals, lakes
5. *Coix aquatica*	N	C	canals, rivers
6. *Salvinia cucullata*	N	NE	lakes
7. *Eleocharis dulcis*	N	NE,S	lakes, canals
8. *Najas graminea*	N	N,NE	canals, lakes
9. *Colocacia esculenta*	E	C,NE	rivers, lakes
10. *Typha latifolia* L.	N	C	lakes

[1]N.B. Origin From: Siamese Plant Name: Botanical Name, Local Name Royal Forest Department, Edition , 18th September 1944, by Phyraya Winitwanandorn, Collected from 1928-1944.

MANAGEMENT STRATEGIES

The primary objective of the aquatic plant control program in Thailand is to provide a level of control compatible with the full range of uses of the water resources of the country. Control methods utilized include *manual control,* which is sometimes effective in small bodies of water and usually limited to shoreline and shallow water areas. *Mechanical controls* include the use of dragline buckets, sometimes in combination with desilting or canal renovation, aquatic weed harvesting and water level manipulation.

ll mechanical control methods are expensive. The high reproduction rate of most troublesome aquatic weeds in Thailand means that many machines, operating on a constant maintenance program, would be needed to obtain the desired levels of control.

Herbicides are used to annually control approximately 200 ha of the estimated 10,000 ha of *Mimosa* in Thailand. These treatments are applied in high priority areas by the Royal Irrigation Department. Manual control and mowing or cutting is also practiced in some areas to keep *Mimosa* populations in check. The primary herbicides used against *Mimosa* are glyphosate (N-Phosphonomethyl) glycine and dicamba (3,6-dichloro-o-anisic acid). Approximately 300 ha of *Eichhornia* are controlled annually with 2,4-D 2,4 dichlorophenoxy acetic acid, amine salt). Also, other governmental agencies, i.e. Electric Generating Authority of Thailand, (EGAT) etc. manage aquatic vegetation. The amount of vegetation controlled by other authorities is not included in this report. In general, the control of other weeds, particularly submersed weeds, in Thailand by chemicals is limited because of the high expense of suitable herbicides and due to the lack of trained personnel to supervise and ensure safety to applicators and the environment. The use of *biological control* for aquatic weed is of particular interest to Thailand[3]. These control methods are

[3]Napompeth, B. 1985. Biological Methods of Aquatic Vegetation Management in Tropical Asia, Paper presented at the Workshop on the Ecology and Management of Aquatic Vegetation in the Tropics, Universities of Indonesia, Jarkarta, March 26-29, 1985.

Figure 1. Map of Thailand showing the major river systems and the physiographic regions which have different aquatic weed populations.

much less expensive to utilize and are readily accepted by the public and governmental agencies. Unfortunately, biocontrols take a long time to develop and effective control agents are sometimes not available for the most serious weed problems. Biological agents used in Thailand include the insects *Episammia pectinicornis* (Hampson) formerly *Namangana pectinicornis* (Hampson) for control of *Pistia stratiotes* L.; *Neochetina eichhorniae* Warner. for control of *Eichhornia*; and *Acanthascelides quadidentus* and *A. puniceus* for *Mimosa* control. Fishes that are used include *Ctenopharyngodon idella* Val.; *Oriochromis niloticus* L. formerly *Tilapia nilotica*; and *Puntius gonionotus*.

Research and control operations on mechanical, chemical and biological control methods is constantly underway in Thailand. Practically, the most effective long term management of aquatic weeds in Thailand is the integration of all of the range of methods into properly executed control programs.

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Management of Salvinia in the Northern Territory

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ABSTRACT

Aquatic weeds are spreading into new areas of the world. *Salvinia molesta* was first reported in Australia's Northern Territory in 1976. Ten more field infestations have since been reported. Chemical, physical and biological methods are being integrated on a regional basis for their control. Five infestations have now been eradicated and two substantially reduced by chemical and physical control methods. Biological control with the weevil *Cyrtobagous salviniae* is proving to be successful but cyclical in nature. In shallow water its success is limited, probably by high temperatures which affect the weevil's reproduction.

Key words: Salvinia molesta, physical control, chemical control, biological control, *Cyrtobagous salviniae*, exotic plants, spread.

INTRODUCTION

Ennis and Vandiver (1979) reported that two of the principal trends in aquatic weed management were the increasing spread and proliferation of exotic weeds into new areas of the world, and the likelihood of greater attention being given to the integration of chemical, physical and biological methods for their control. These trends have certainly shown to be true in Australia's Northern Territory, where no alien aquatic weeds were known to occur until the mid 1970s.

The Northern Territory covers an area of 1,346,200 kms, one sixth of the area of Australia. Its population is 155,800, representing only 0.93% of the country's total. This does not, however, mean that weed problems are any less than in more populous areas, but it does mean that there are fewer people to detect and control weeds.

The climate, vegetation and landforms vary considerably from the arid interior to the coast. It is in the higher rainfall and consistently warm areas that introduced tropical aquatic weeds pose the biggest threat, but they do also have the potential to cause localized problems in water storages in the arid zone.

The asexually reproducing free floating aquatic fern, salvinia (*Salvinia molesta* D. S. Mitchell) is believed to have been introduced into Australia as an ornamental plant, having first been collected in the south-eastern part of the continent in 1952 (Harley and Mitchell 1981). It was apparently spread around the country by man through the aquarium and horticultural trade, and by personal exchanges of plant material (Mitchell 1978). It was first found in the Northern Territory in a pool at a Darwin plant nursery in August 1976. In September 1976, the first field infestation was recorded in a lagoon in the remote town of Nhulunbuy. Between 1977 and 1988, ten more field infestations were recorded. These infestations represent the most northerly field occurrences of salvinia in Australia (Finlayson and Mitchell 1982).

Mean temperatures at Darwin in the hottest month (November) are 33.4 C maximum, 25.9 C minimum, and in the coolest month (July) are 29.8 C maximum, 20.2 C minimum, with an annual rainfall of 1600 mm which falls mainly in the November-March period (Anon. 1975). Many perennial waterways occur, so conditions are ideal for the growth and spread of salvinia (Mitchell and Tur 1975).

The detrimental effects of salvinia have been well documented, being similar to those caused by other aquatic weeds (Harley and Mitchell 1981). Therefore, when salvinia was first reported in Darwin, the Government commenced a public awareness and control program. At that time biological control agents were not available for salvinia in Australia, so chemical and physical methods were used. Despite the statement by Thomas and Room (1986)

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