A STUDY OF THE EFFECTS OF INVASIVE PLANT SPECIES ON SMALL MAMMALS IN HUDSON RIVER FRESHWATER MARSHES

Final Report to the Tibor T. Polgar Fellowship Program

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ABSTRACT: Invasive plant species such as *Phragmites australis* and *Lythrum salicaria* are known to displace native flora and thought to alter the habitat of native fauna, resulting in loss of diversity. To infer effects of invasive plant species on the ecosystem this study compares select characteristics of one faunal community in habitats dominated by the indigenous narrowleaf cattail, *Typha angustifolia* to the characteristics of similar communities in habitats dominated by the invasive common reed, *Phragmites australis* and purple loosestrife, *Lythrum salicaria*. The faunal community that was the subject of this study was the small mammal community of Tivoli North Bay marsh in Dutchess County, New York. This was a preliminary study to determine not only the nature of the data to be collected, but also how to collect it. *Peromyscus leucopus* and *Microtus pennsylvanicus* were the two species trapped. The data, although limited, were in direct contradiction to current ecological belief: *Peromyscus* were numerous in areas dominated by both native and invasive plant species. A comparison of characteristics of the marsh *Peromyscus* to the woodland *Peromyscus* indicated that the marsh is not a marginal habitat; the marsh *Peromyscus* weighed more on average, bred later in the season and had no deer species tick loads. More detailed studies are indicated.

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INTRODUCTION

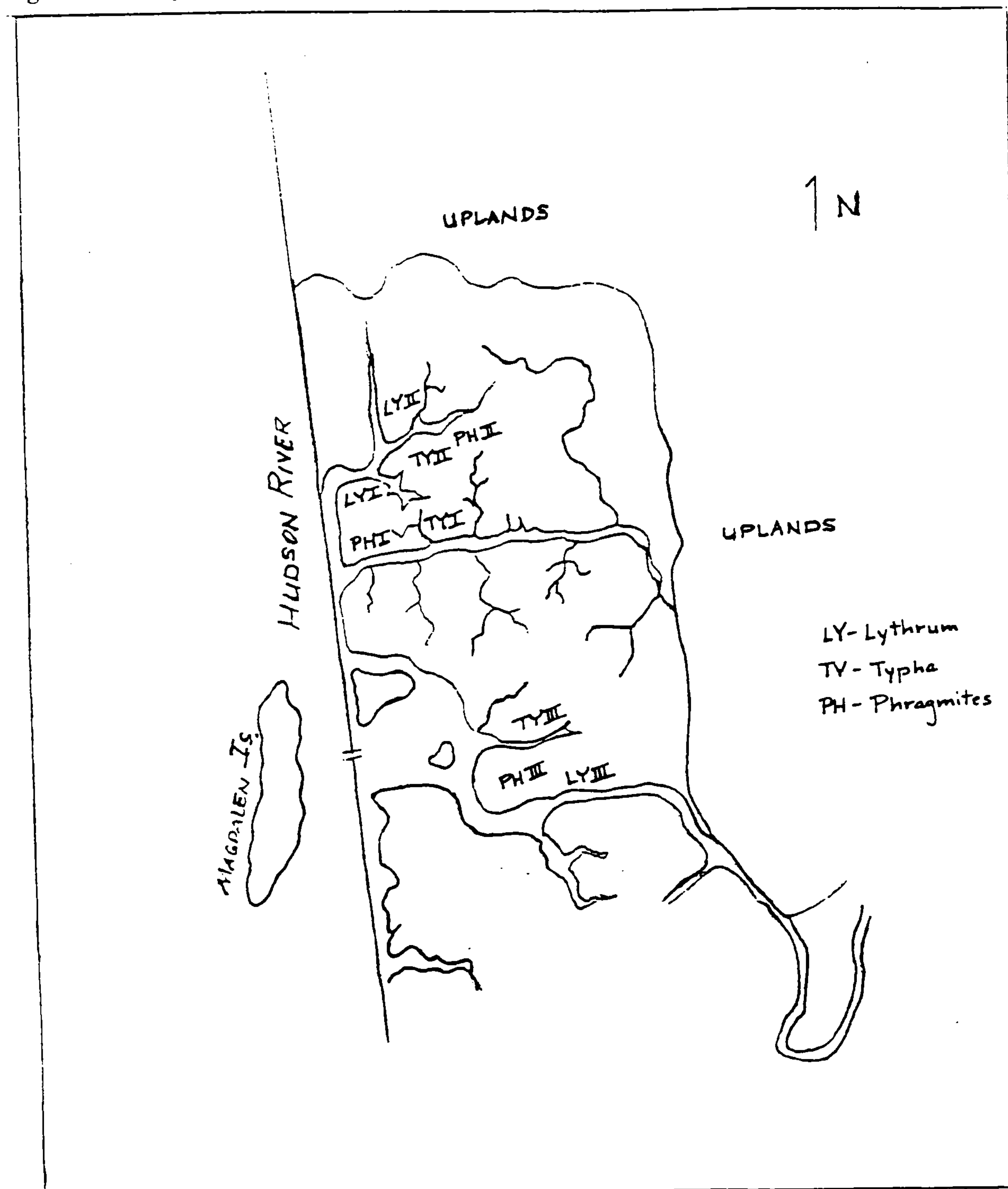
It has been hypothesized that invasive flora has a detrimental effect on the environment of freshwater tidal marshes (Faber 1982; Rawinski and Malecki 1984; Redington 1994). If the hypothesis is accepted, it would imply that environmental regulators and managers could be confronted with potentially very costly projects, in terms of money and unforeseen effects on the ecosystem involved, for the removal of nonindigenous plant species and the restoration of the marshes to pre-invasive species condition. However, there are currently few studies that test this hypothesis (Anderson 1995). In the Hudson River estuary very little research has focused on the effects of invasive plant species, with the exception of the Findlay and Groffman (1997) study on the effects of *Phragmites australis* and *Lythrum salicaria* on nutrient cycling in the marshes. However, the results of this study were inconclusive as to whether or not the way in which these species use available nutrients is detrimental to native flora.

Our study also focused on *L. salicaria* and *P. australis*. We hypothesized that these two invasive plant species would not affect the fauna of the freshwater marsh ecosystem. The faunal community chosen was the small mammal community because no studies on the Hudson River estuary have examined this community (Anderson and Schmidt 1989; Bohne and Schmidt 1989; Brzorad and Burger 1990; Green et al. 1988; Kiviat 1980, 1996, 1997; Kiviat and Barbour 1996; Swift 1987). Another reason for this choice is that small mammal habitat requirements and diets, in many cases, are so specific that a change in a characteristic species composition of the small mammal community may be indicative of a very particular change in its habitat (Inoye et al. 1987).

Besides their value as indicators of the effects of invasive species, small mammals may play an important role in the ecology of the freshwater tidal marsh. They may link the aquatic and terrestrial ecosystems. They also prey on invertebrates and are known to keep various insect populations in check (Nowak 1991). Several species consume and destroy plant material (Fritzell 1988) and may be involved in seed dispersal and plant propagule transport (Kiviat 1989). In turn, small mammals are the prey of marsh hawks, owls, snakes and large fish (Hodgson and Kitchell 1987). Small mammals may also influence nutrient cycling through deposition of feces (Kiviat 1989). And they may serve as a reservoir for various diseases including Lyme disease (Ostfeld 1997).

We expect faunal communities in native (*Typha angustifolia*) and invasive flora not to differ in species composition, overall population density, individual weight and age class structure. Such differences might be attributed to differences in the density of cover, in the quality and availability of nesting material and in the types of forage provided by the two types of plants and the flora associated with them (Fritzell 1988; Kiviat 1989; Rawinski and Malecki 1984).

Figure 1. Study sites in the northern section of Tivoli North Bay



Scale = 1in.:12000ft

METHODS

Both *Lythrum salicaria* and *Phragmites australis* were first noted in the Hudson River National Estuarine Research Reserve (HRNERR) at Tivoli North Bay (Figure 1) some time during the mid-1950's to early 1960's (Winogrond and Kiviat 1997). Examination of historical aerial photographs indicates an increase in the areas covered by these species in this marsh since that time (1997). *Typha angustifolia* was the vegetation displaced by the invasive species.

Surveys of small mammals were conducted in three vegetation community types in Tivoli North Bay: *P. australis*, *L. salicaria* and *T. angustifolia*. Three grids were set up in each community type at each site (N=3 sites). The community type of each grid was verified before trapping by surveying percent cover of vegetation species within one square meter. Grids of the same community type were more than 100 meters apart. Grids of different community types at a chosen site were grouped closely together to facilitate transport of equipment and checking of traps. The grids were two intersecting 40 meter transects, running north to south and east to west, with two traps set at 10 meter intervals for a total of 18 traps per grid. The traps used were 6"x 2.5"x 2" folding Sherman traps.

Each trap was placed on a platform capable of floating upright during high tide. Each platform was constructed of two capped empty plastic bottles held in place by ¼" rubber bands. Traps were anchored to the bottles using rubber bands at an angle perpendicular to the length of the bottles. Rubber bands were looped around bottles and poles to allow the trap unit to rise and fall with the tides and remain upright (Figure 2).

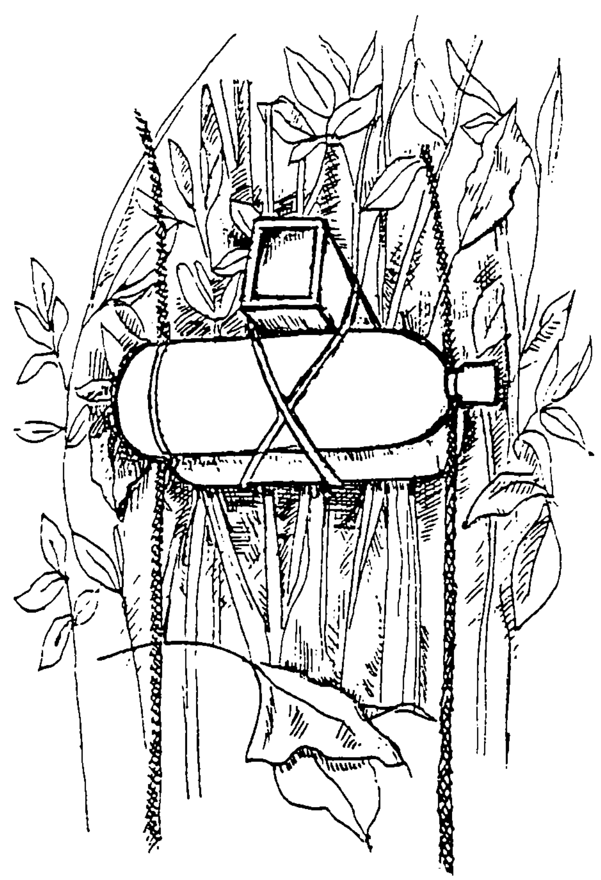
Each site was prebaited for at least two days with a 1:3 mixture of peanut butter and crimped oats. One grid of each community type, a total of three grids, was trapped for three consecutive nights at each site. Traps were set between 16:00 and 18:00 and checked between 6:30 and 9:00.

The following data were recorded for each individual: date, time, site, grid, trap, community type, species, sex, age class, weight, breeding condition, and tick load. Ear measurements, foot measurements, tail measurements and coloration were also noted if necessary for species identification. Clipping fur near the base of the tail temporarily marked all individuals caught.

The small mammal data were then analyzed using one-way ANOVA with randomized block design (Type I with fixed effects), t-tests for independent samples, Kruskal-Wallis ANOVA by ranks test, and the Schumacher and Eschmeyer Method for population estimation. The latter method was used with the assumption of a closed population, which is realistic for short trapping sessions (Krebs 1989).

The marsh mice data were then compared to uplands mice data using descriptive statistics and t-tests for independent samples. The woodlands mice data were taken from an ongoing study being conducted at the Institute of Ecosystem Studies in Millbrook, New York.

Figure 2. Trap configuration



RESULTS

The percent cover of the dominant vegetation in the *Typha*, *Phragmites* and *Lythrum* vegetation types varied between 40% and 99%. In most cases of the *Lythrum* vegetation type the percent cover was between 40% and 50%.

Table 1. Percent cover by species in each vegetation community

Typha Community	Phragmites Community	Lythrum Community
Typha angustifolia 53.3%	*Phragmites australis* 97.3%	*Lythrum salicaria* 55%
Impatiens capensis 33.3%	*Impatiens capensis* 2.7%	*Typha angustifolia* 23.33%
Peltandra virginica 10%		*Impatiens capensis* 10%
Lythrum salicaria 10% (occurred at one site only)		*Peltandra virginica* 5%
		Bare ground 30% (occurred at one site only)

During the three-week trapping period two *Microtus pennsylvanicus* and thirty-seven *Peromyscus leucopus* were caught and marked. All statistical tests were performed on only the *P. leucopus* data.

Sites

The greatest number of mice was found at Site I on the westernmost edge of the northern marsh (Figure 1). This area was farthest from the eastern shore of the uplands and separated from the northern shore by a large tidal creek and a distance at least equal to that of Site III from the eastern shore of the uplands (Table 2). Even though mouse abundance appeared to vary among sites, the difference was not statistically significant ($F=4.62$, $p=0.08$).

Table 2. Mean number of mice by site across all vegetation types

Site	Mean Number of Mice	S.E.
I	6.66	.416
II	3.00	.887
III	2.67	.699

Mice with the highest mean weight and highest mean adult weight were found at Site III (Table 3), which was the closest of the sites to the woodland area.

Table 3. Mean adult weights and mean weights of mice by site across vegetation types

Site	Mean Adult Weight	S.E.	Mean Weight	S.E.
I	25.9	5.43	24.25	7.98
II	22.80	2.75	20.13	3.05
III	29.00	1.96	25.38	2.17

Vegetation Types

The abundance of mice did not differ among the three vegetation types (F=1.05, p=0.42). With the exception of *Lythrum*, all age classes were found in all vegetation types (Table 4).

Table 4. Mean number of mice by vegetation type across all sites

Vegetation Type	Mean Number of Mice
Phragmites australis	5.33 ± 0.771
Typha angustifolia	4.33 ± 0.437
Lythrum salicaria	2.67 ± 0.745

Although mean weights and mean adult weights (Table 5) seemed to vary among vegetation types these differences were not significant [H (2, N=32)=1.30, p= .52; H (2, N=21)=. 26, p=. 88].

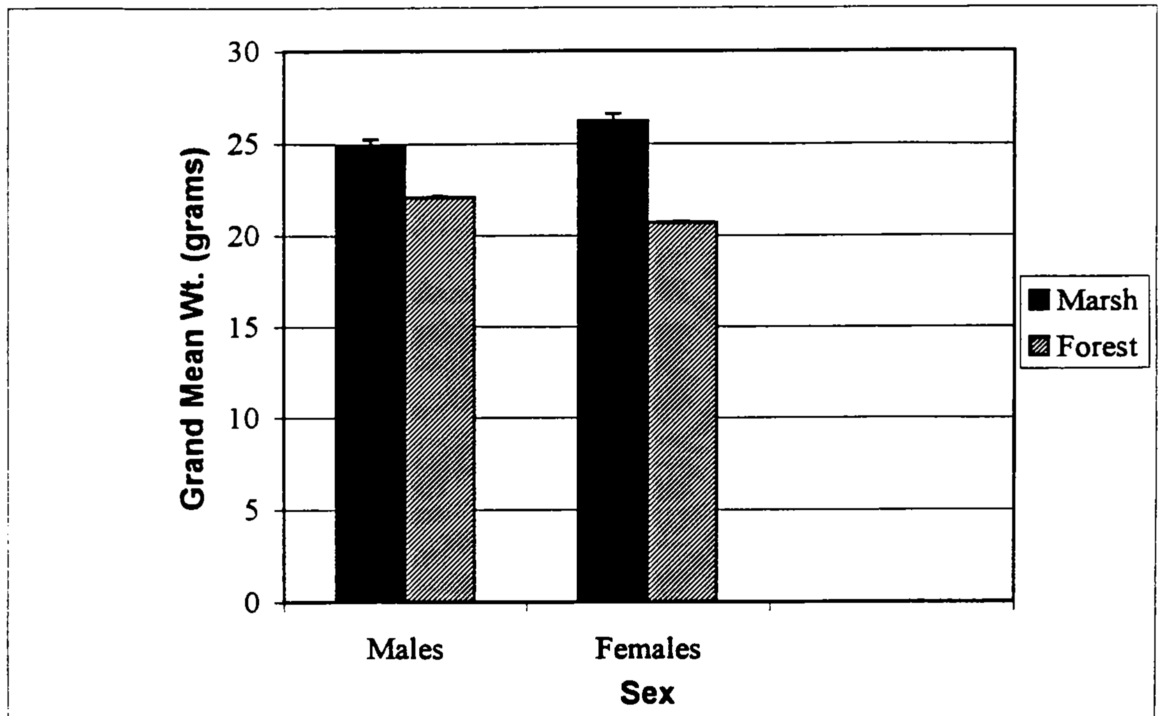
Table 5. Mean adult weights and mean weights of mice by vegetation type across all sites

Vegetation Type	Mean Adult Weight	Mean Weight
Phragmites australis	25.33 ± 1.99	22.57 ± 1.61
Typha angustifolia	26.57 ± 2.01	23.50 ± 1.82
Lythrum salicaria	25.40 ± 0.68	25.67 ± 0.614

Marsh versus upland

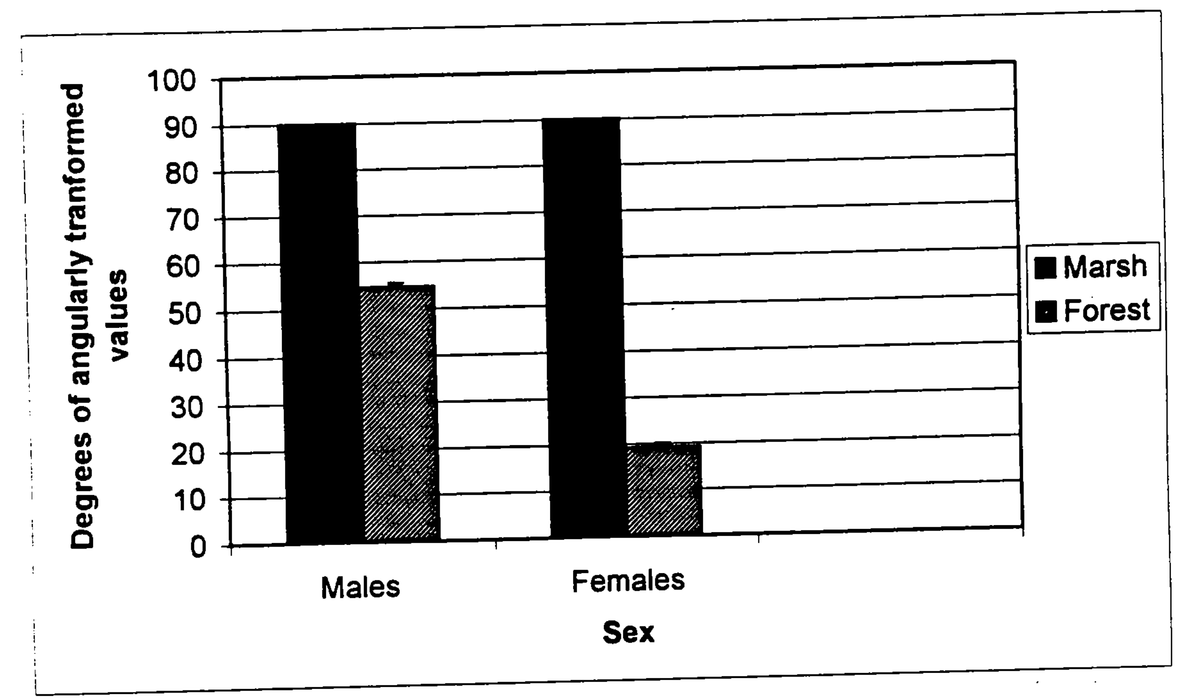
Both males and females in the marsh outweighed, on average, their counterparts in the woodlands (Figure 3). The difference between mean adult weights in the forest and marsh was just significant (t=-4.22, df=2, p=.05). However, the differences between mean adult weights of males and females in the forest and marsh were not significant (t=.01, df=2, p=0.99).

Figure 3. Mean weights of male and female *Peromyscus leucopus* in the marsh and forest



The percentage of males and females in breeding condition were higher in the marshes than in the woodlands. During the period of 28 June-July 7, 1999 approximately 11% of females were in breeding condition in the uplands, while in the marsh 100% of the females were in breeding condition (Figure 4). During the same time period 63.7% of males were in breeding condition in the uplands and 100% in the marsh (Figure 4). The difference between the proportion of females in breeding condition in the woodlands and marsh was significant ($t=12.66$, $df=5$, $p<0.01$). The difference between the proportion males in breeding condition in the woodlands and marsh was significant ($t=5.36$, $df=5$, $p<0.01$).

Figure 4. Means of angularly transformed values of the proportion of male and female species in breeding condition in the forest and marsh



DISCUSSION

The small mammal communities in native (*Typha angustifolia*) and invasive flora did not differ significantly in species composition, overall population number, body weight and age class structure. *Peromyscus* were found in all habitats and once mean weights were calculated for adults there was little difference in body mass among mice caught in any of the three vegetation types. The uniformity of body mass in adult mice indicates that the resource abundance in all three habitats was similar.

Additional evidence of the mice maintaining healthy populations in all marsh habitats is that their density was relatively high and constant across habitat types and they were at least as abundant far from the uplands as near. In fact, since the site with the greatest number of mice was farthest from the uplands, the idea that extensive waterways/tidal creeks act as barriers to movement was not supported.

Most importantly, in comparison to the mice in the forest, mice in the marsh had higher body masses and a greater percent were in breeding condition. The difference in percent in breeding condition may be attributed to the seasonal lag in the growth of vegetation between the marsh and the woods; the marsh is most lush in July, while the woods have foliage by May (Holland and Smith 1980).

These data support the results of Anderson's review (1995): they exhibited no significant difference between vegetation types in species composition, overall population density and individual weight. Therefore our hypothesis that *P. australis* and *L. salicaria* would have no effect on the small mammal community has not been rejected. The effects of invasive species may not necessarily be negative depending upon the

species studied and the ecosystem involved. This seems to be the case for *Peromyscus leucopus* in the freshwater tidal marsh.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research could address two areas of interest: the natural history of *Peromyscus* and their role in the ecosystem. Research could focus on why *Peromyscus* in the marsh are heavier, and possibly healthier, than *Peromyscus* in the uplands and what the mice in the marsh are eating. Studies of nesting behavior and nest locations would be useful in determining how *Peromyscus* deal with high tide. Also, the interactions of *Peromyscus* with other species, in terms of predation and resource competition, could be examined.

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