Aquatic Botany, 40 (1991) 185–193
Elsevier Science Publishers B.V., Amsterdam

Decomposition and colonization by invertebrates of *Typha latifolia* L. litter in Chaco cattail swamp (Argentina)

Idalia Y. Bruquetas de Zozaya and Juan José Neiff
Centro de Ecología Aplicada del Litoral (CECOAL), Casilla Correo 291 (3400) Corrientes, Argentina

(Accepted for publication 7 December 1990)

ABSTRACT

Bruquetas de Zozaya, I.Y. and Neiff, J.J., 1991. Decomposition and colonization by invertebrates of *Typha latifolia* L. litter in Chaco cattail swamp (Argentina). *Aquat. Bot.*, 40: 185–193.

Litter containers with dead leaves of *Typha* were submersed above and under a floating island, and were also suspended in air. Three litter containers were retrieved from each site after 7, 15, 30, 45, 75 and 150 days. Dry weight losses and decay coefficients were calculated. After 150 days of immersion, litter decomposition was 50% and 39% of the initial weight for samples incubated above and under the floating island, respectively. Samples suspended in air decomposed more slowly; at the end of the study only a 16% weight loss had occurred. Maximum densities of invertebrates were found in samples above the floating island. In both submersed conditions, the 'collector' invertebrates were the most abundant. 'Predators' and 'shredders' were found in lower abundance. 'Scrapers' only colonized the habitat above the floating island. Litter suspended in air was not colonized by invertebrates.

INTRODUCTION

Emergent hydrophytes cover a considerable area in the northeastern swamps of Argentina. This riparian vegetation (mainly *Typha latifolia* L., *Cyperus giganteus* Vahl and *Thalia multiflora* Horkel) is characterized by a high annual production (15–22 t ha^{-1}) (Neiff, 1981). Decay rates and accumulation of plant litter are increased by environmental variability, mainly fires and invertebrate activities (Bruquetas de Zozaya, 1986).

The high annual turnover rate of organic plant matter and low decomposition (Dykyjová and Květ, 1978; Ulehlová, 1978a,b; Neiff, 1981) produces a constant accumulation of dead vegetable tissues which form a floating base, on top of which develops a continuous cover of vegetation with herbaceous, shrublike, and even arboreal species in the more advanced stages of development (Neiff, 1982, 1986).

These floating or anchored formations called 'embalsados' (known as 'sudd',

0304-3770/91/$03.50

'flotant' or 'plav' in the current literature) originate in lakes and ox-bow-lakes with little hydrometric fluctuation.

Extensive data exist on the decomposition process of different species of *Typha* (Mason and Bryant, 1975; Davies and van der Valk, 1978; Howard-Williams and Howard-Williams, 1978; Danell and Anderson, 1982; Kulshreshtha and Gopal, 1982; Sharma and Gopal, 1982; Petersen, 1984). Boyd (1970) has examined the decomposition of *T. latifolia* in some detail.

The importance of emergent vegetation to the energy budget of pond littoral ecosystems has been made clear in several contributions (Dykyjová and Květ, 1978; Ulehlová, 1978a,b; Ulehlová and Přibil, 1978).

Very little is known about the role of invertebrates in the decomposition of *Typha* litter (Mason and Bryant, 1975; Hill and Webster, 1982). *Typha latifolia* litter can decompose in the air at the water surface among the plants of floating islands and submersed under the sudd.

We report observations and in situ experiments on the decomposition rates for *T. latifolia* litter and on colonization by invertebrates under the three environmental conditions discussed above.

SITE AND METHODS

The pure *T. latifolia* stand for this study was located at the La Cava cattail swamp, a water body 0.6 ha in area, situated on the westside of the Paraná River valley (27°27′S, 58°57′W). The study area has hot summers and mild winters. The mean maximum temperature in the period August–December 1986 was 29°C and the mean minimum was 17.9°C.

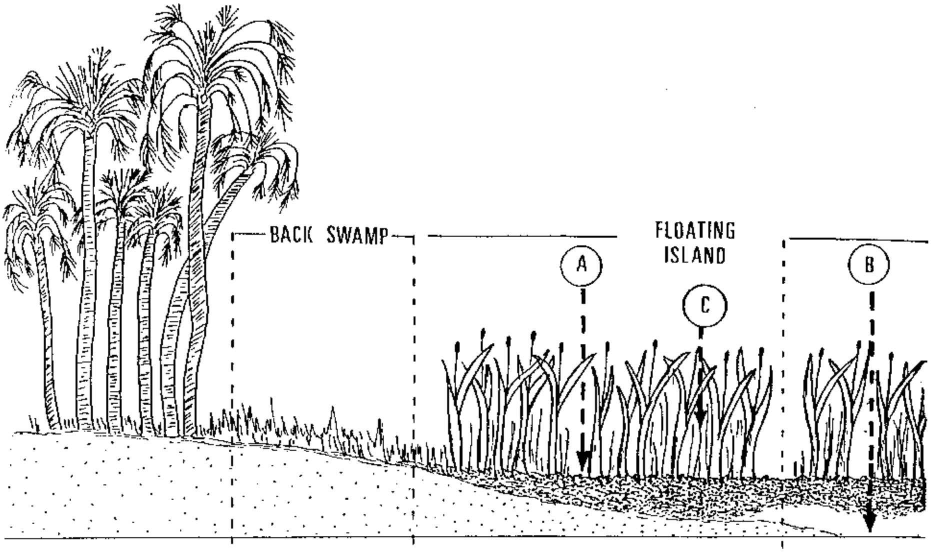
Three sites were chosen for investigation of the decomposition rates of *T. latifolia*. Site A was just below the water surface at 20 cm depth, but above the floating island. Site B was under the floating island, at approximately 2 m depth. Site C was situated in air, 15 cm above the water surface where the temperature had a daily variation of 15°C. Environmental features vary from site to site (Fig. 1).

During the incubation time, the water depth of the swamp varied from 2.3 m in August to 1.8 m in December.

Dead standing leaves of *T. latifolia* were harvested in July 1986 and air dried. Samples were cut into segments 10 cm long and placed into cylindrical containers (diameter, 8.5 cm; height, 15 cm), with 300 holes of 5 mm diameter. Each container was filled with 10 g (air dry weight) of *T. latifolia* leaves. At each site 18 litter containers were incubated.

The experiment was started in August 1986. Three samples were retrieved from each site after 7, 15, 30, 45, 75 and 150 days. In the laboratory, the invertebrates present in the litter were sorted and preserved in 4% formalin. The remaining plant material was dried thereafter to constant weight at 105°C.

The amount of plant litter decomposed was expressed as dry weight loss.



ENVIRONMENTAL FEATURES		Back swamp	Floating island (A, C)	B
WATER TEMPERATURE	°C	20.1–27.5	16.5–27.1	14.9–27.0
pH		5.5–6.3	5.5–6.2	5.3–5.9
CONDUCTIVITY	$\mu S\ cm^{-1}$	60–100	57–90	71–80
OXYGEN	$mg\ l^{-1}$	0.9–5.5	0.4–1.5	0.3–0.2
SO_4	"	2.0	2.0	8.0
NO_3–N	$mg\ l^{-1}$	N.D.	N.D.–0.044	N.D.–0.15
NO_2–N	"	N.D.	N.D.	N.D.
NH_4–N	"	0.150	0.140	0.170
TOTAL–P	$mg\ l^{-1}$	0.106–0.256	0.080–0.230	0.144–0.4
COD	"	53–60.5	29.0–72.0	34.1 –38
DEPTH	m	0–0.40	1.7–2.0	1.8–2.3

Fig. 1. Location of *Typha* litter container and environmental features. A, above floating island; B, under floating island; C, air suspended.

The decay coefficient was calculated according to Olson (1963). The number of invertebrates was expressed per gram of dry weight remaining (105°C) and per litter bag. Water samples were analyzed according to methods recommended by the U.S. Environmental Protection Agency (1983).

RESULTS

The decomposition of submerged *Typha* litter was more rapid during the early days of incubation (Fig. 2, curves A and B) in all incubation conditions. After 7 days losses were more gradual. At the end of the experiment (150 days), the litter incubated in water above the floating island showed greater

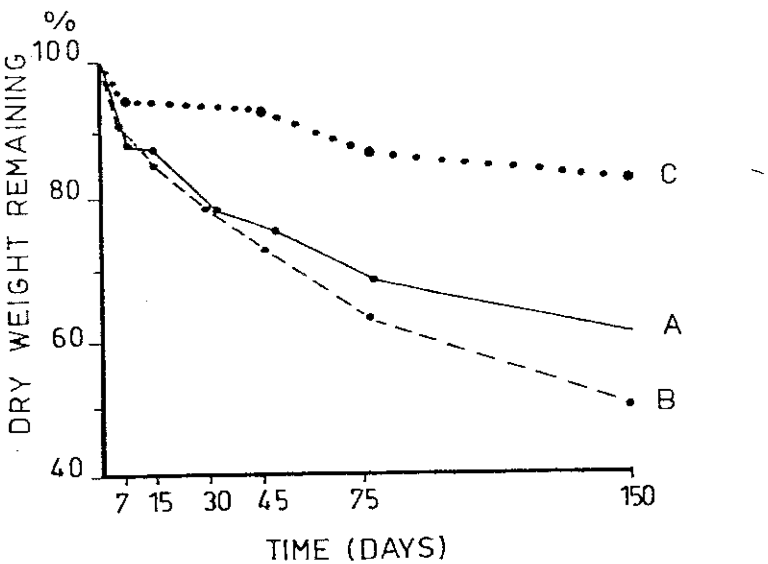


Fig. 2. Percentage of *Typha latifolia* litter decomposed (as percentage of initial dry weight). A, under floating island; B, above floating island; C, air suspended.

TABLE 1

Estimated times (days) for 50 and 95% decomposition and decay coefficients for *Typha latifolia* litter

Location of *Typha latifolia* litter container	r^1	n^2	Decay coefficient (k)	50% decomposition	95% decomposition
Above floating island	0.98	18	0.004	173	750
Under floating island	0.92	18	0.003	231	1000
Air suspended	0.94	18	0.001	693	3000

[1]Regression coefficient.
[2]Number of samples.

losses of phytomass than that under the island (50% and 39%, respectively). The estimated time for 50% decomposition (or 'half-life') for *Typha* litter (Table 1) was 231 days under the floating island (decay coefficient (k)=0.003) and 173 days for litter incubated above the floating island (k=0.004).

Losses of phytomass from air-suspended *Typha* litter progressed more slowly than for submerged litter (Fig. 2C). After 150 days only 16% had decomposed. The calculated half-life value was 693 days (k=0.001). In the *Typha* litter placed above the floating island the invertebrate densities reached a

TABLE 2

Number of invertebrates per litter container and per gram remaining in *Typha latifolia* litter and functional groups. Assigned according to Merrit and Cummins (1978)

	Taxa[1]	Time (days)											
		7		15		30		45		75		150	
		A[2]	B[3]	A	B	A	B	A	B	A	B	A	B
	Nematoda	–	–	–	1	–	–	–	1	–	–	2	–
C	Oligochaeta	–	28	2	101	–	3	–	24	–	72	2	47
	Dero (Dero) pectinata Aiyer												
	Dero botrytis Marcus												
	Dero (Dero) evelinae Marcus												
	Dero (Aulophorus) furcatus Müller												
	Hirudinea												
P	*Helobdella stagnalis* (L.)	–	–	–	1	–	–	–	3	–	–	–	6
	Ostracoda												
C	*Cytheridella ilosvayi* Daday	–	2	–	1	–	–	–	–	–	1	4	3
	Amphipoda												
C	*Hyalella curvispina* Shoemaker	–	1	–	–	–	–	–	–	–	–	–	–
	Collembola												
C	*Proisotoma* sp.	–	–	–	–	1	–	–	–	–	–	1	–
	Hemiptera												
P	*Belostoma micantulum* Stal	–	–	1	–	–	–	–	–	–	–	–	7
	Coleoptera												
P	*Celina* sp. (adults)	–	–	–	–	–	–	–	–	–	–	2	–
C	*Scirtes* sp. (larvae)	–	–	–	–	–	–	–	–	–	–	–	206
C	*Berosus* sp. (adults)	–	–	–	–	–	–	1	–	–	–	–	–
	Diptera (larvae)												
Sh	*Hydrellia* sp.	–	–	2	2	–	–	–	–	–	1	–	4
C	*Uranotaenia* sp.	–	–	–	–	–	–	–	–	–	–	1	–
C	*Chironomus* sp.	–	–	–	1	–	–	–	–	–	–	–	2
	Oribatei												
C	*Hydrozetes* sp.	1	3	1	2	2	–	–	–	–	2	1	3
	Mollusca												
Sc	*Uncancylus concentricus* (d'Orb.)	–	8	–	4	–	4	–	3	–	–	–	–
Sc	*Drepanotrema lucidum* Pfeiffer	–	13	–	4	–	2	–	–	–	–	–	2
Sc	*Drepanotrema cimex* Moricand	–	1	–	–	–	–	–	–	–	–	–	2
	Total of individuals per container	0.3	18.6	2	39	1.3	3	0	10.6	0	25.3	4.3	94
	S.D.	0.5	6.5	2	11.2	0.5	0		4.7		9.7	3.5	58.2
	No. of individuals per gram remaining	0	2	0	5	0	0	0	1	0	4	1	21

[1]C, collectors (filterers and gatherers); P, predators; Sc, scrapers; Sh, shredders.
[2]Under floating island.
[3]Above floating island.

maximum of 21 individuals per gram of remaining litter (Fig. 2B). After 15 days incubation, Oligochaeta (*Dero pectinata, Dero botrytis, Dero evelinae*) were the most important; at the end of the experiment *Scirtes* spp. were the most abundant. The molluscs (Planorbidae and Ancylidae) were found only above the floating island (Table 2).

Significant differences were found in the number of individuals per litter container incubated under and above the floating island (Mann U test). After 150 days of immersion, the density under the island did not exceed one invertebrate per gram of remaining litter. The litter suspended in the air was not colonized by macroinvertebrates.

DISCUSSION

The rates of decomposition of *T. latifolia* litter can be arranged in decreasing order: above the floating island, under the floating island, air suspended. The slow decomposition of air-suspended *T. latifolia* litter may be related to daily variations in the microclimate and to the scarce microbial activity. Temperature, moisture content and aeration are recognized as driving variables of the decomposition processes (Ulehlová, 1978b). According to Boyd (1970), initial increases in nitrogen content, related to microbial activity, were not found in air-suspended *T. latifolia* litter.

On the surface of the floating island, at 20 cm water depth, the dry weight loss of *T. latifolia* litter found in the study was similar to that reported by Boyd (1970) for a temperate pond.

In contrast, *Typha* litter decomposition in this study and in a tropical lake (Howard-Williams and Howard-Williams, 1978) was more rapid than in temperate regions (Puriveth, 1980; Danell and Anderson, 1982; Hill and Webster, 1982). Webster and Simmons (1978) found the fastest decomposition ($k=0.01$) for *T. latifolia* in a temperate reservoir. Thus, the data decay coefficients in these papers reveal that the negative correlations of decomposition with latitude for *Typha* (Kulshreshtha and Gopal, 1982) are not consistent. In long-term studies on a wetland, Ulehlová (1978a,b) found definite temporal patterns related to temperature: decomposition rates were about three times higher in summer than in winter.

The estimated time for the half-life for *T. latifolia* incubated under the floating island was greater than above the sudd. Dissolved oxygen concentrations appeared to be responsible for the decrease in decomposition rates under the floating island (Table 1, Fig. 1). Godshalk and Wetzel (1978) reported that structural characteristics of the plants and the oxygen content of water influence decomposition rates. Leaves and roots of *Eichhornia crassipes* (Mart.) Solms incubated under *T. latifolia* in a simultaneous experiment (Poi de Neiff and Neiff, 1988) decomposed much faster than *T. latifolia* because of their relatively low fibre content. The cellulose content of

Eichhornia (leaves and roots) was lower than that of *Typha* (Almazán and Boyd, 1978). A marsh community composed of genera such as *Typha* and *Scirpus* will have less protein in the dry matter than a community composed of submersed or floating plants.

Macroinvertebrate densities associated with *Typha* detritus on the surface of the floating island were, at 75 days, within the range found by Hill and Webster (1982) for *T. latifolia*. After 150 days of incubation, however, the density in this study was higher. The trends of increasing macroinvertebrate colonization with increasing exposure time were mentioned for terrestrial leaf litter (Petersen and Cummins, 1974) and for *Typha* litter (Hill and Webster, 1982). This occurs as a result of leaves becoming more palatable owing to their conditioning by microbial decomposers. The increase in nitrogen during decomposition was pointed out by Ulehlová (1978b) in wetlands of *Typha angustifolia* L. and *Phragmites communis* Trin. as an active accumulation.

Collectors were the most abundant, especially *Dero* (*Dero*) spp. (Oligochaeta) during incubation and *Scirtes* spp. (Coleoptera larvae) were abundant at the end of the study. Under the floating island, colonization by invertebrates was scarce (Table 2).

Macroinvertebrate densities increased slightly in *E. crassipes* leaf litter incubated under *T. latifolia* (Poi de Neiff and Neiff, 1988) but were lower than densities found under aerobic conditions (Poi de Neiff and Neiff, 1989). Hart and Howmiller (1975) and Petersen and Cummins (1974) showed that higher densities of invertebrates occur on those leaves which decompose most rapidly. In helophyte communities, low dissolved oxygen content limited the distribution of invertebrates with definite demands on oxygen (Dvorak, 1978). The combination of high fibre content, low dissolved oxygen content and acidic pH may have contributed to the low decomposition of *T. latifolia* and limited the number of invertebrate colonizers.

REFERENCES

Almazán, G. and Boyd, C.E., 1978. Effects of nitrogen levels on rates of oxygen consumption during decay of aquatic plants. Aquat. Bot., 5: 119–126.

Boyd, C.E., 1970. Losses of mineral nutrients during decomposition of *Typha latifolia*. Arch. Hydrobiol., 66: 511–517.

Bruquetas de Zozaya, I.Y., 1986. Fitófagos y otros invertebrados que habitan esteros densamente vegetados del Chaco Oriental. Ambiente Subtropical, 1: 160–175.

Danell, K. and Anderson, A., 1982. Dry weight loss and colonization of plant litter by macroinvertebrates: plant species and lake types compared. Hydrobiologia, 94: 91–96.

Davies, C.B. and van der Valk, A.G., 1978. Litter decomposition in prairie glacial marshes. In: R.F. Good, D.F. Whigham and R.L. Simpson (Editors), Freshwater Wetlands. Academic Press, New York, pp. 99–113.

Dvorak, J., 1978. Macrofauna of invertebrates in helophyte communities. In: D. Dykyjová and

J. Květ (Editors), Pond Littoral Ecosystems. Structure and Functioning. Springer, New York, pp. 389–395.

Dykyjová, D. and Květ, J. (Editors), 1978. Pond Littoral Ecosystems. Structure and Functioning. Ecology Studies No. 28. Springer, New York, 464 pp.

Godshalk, G. and Wetzel, R., 1978. Decomposition of aquatic angiosperms. II: Particulate components. Aquat. Bot., 5: 301–327.

Hart, S.D. and Howmiller, R.P., 1975. Studies on the decomposition of allochthonous detritus in two southern California streams. Verh. Int. Ver. Limnol., 19: 1665–1674.

Hill, B.H. and Webster, J.R., 1982. Aquatic macrophyte breakdown in an Appalachian river. Hydrobiología, 89: 53–59.

Howard-Williams, C. and Howard-Williams, W., 1978. Nutrient leaching from the swamp vegetation of lake Chilwa, a shallow African lake. Aquat. Bot., 4: 257–267.

Kulshreshtha, M. and Gopal, B., 1982. Decomposition of freshwater wetlands vegetation. II. Above ground organs of emergent macrophytes. In: B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (Editors), Wetlands: Ecology and Management. International Scientific Publications, Jaipur, pp. 279–292.

Mason, C.F. and Bryant, R.J., 1975. Production, nutrient content and decomposition of *Phragmites communis* Trin. and *Typha angustifolia* L. J. Ecol., 63: 71–95.

Merritt, R. and Cummins, K.W., 1978. An Introduction to the Aquatic Insects of North America. Kendall Hunt, IA, 441 pp.

Neiff, J.J., 1981. Panorama ecológico de los cuerpos de agua del nordeste Argentino. Symposia, VI Jornadas Argentinas de Zoología. Ramos Americana, La Plata, pp. 115–151.

Neiff, J.J., 1982. Esquema sucesional de la vegatación en islas flotantes del Chaco Argentino. Bol. Soc. Arg. Bot., 21 (1–4): 325–341.

Neiff, J.J., 1986. Aquatic plants of the Paraná system. In: B.R. Davies and K.F. Walker (Editors), The Ecology of River System. Junk, Netherlands, pp. 557–571.

Olson, J.S., 1963. Energy storage and the balance of producers and decomposers in ecological systems. Ecology, 44: 322–331.

Petersen, R.C., 1984. Detritus decomposition in endogenous and exogenous rivers of a tropical wetland. Verh. Int. Ver. Limnol., 22: 1926–1931.

Petersen, R.C. and Cummins, K.W., 1974. Leaf processing in a woodland stream. Freshwater Biol., 4: 343–368.

Poi de Neiff, A. and Neiff, J.J., 1988. Decomposition of *Eichhornia crassipes* (Mart.) Solms in a pond of Parana river valley and colonization by invertebrates. Trop. Ecol., 29: 79–85.

Poi de Neiff, A. and Neiff, J.J., 1989. Dry weight loss and colonization by invertebrates of *Eichhornia crassipes* litter under aerobic conditions. Trop. Ecol., 30: 175–182.

Puriveth, P., 1980. Decomposition of emergent macrophytes in a Wesiasin marsh. Hydrobiología, 72: 231–242.

Sharma, K.P. and Gopal, B., 1982. Decomposition and nutrient dynamics in *Typha elephantina* Roxb. under different water regimes. In: B. Gopal, R.E. Turner, R.G. Wetzel and D.F. Whigham (Editors), Wetlands: Ecology and Management. International Scientific Publications, Jaipur, pp. 321–334.

Ulehlová, B., 1978a. Decomposers in the fishpond littoral ecosystem. In: D. Dykyjová and J. Květ (Editors), Pond Littoral Ecosystems. Structure and Functioning. Springer, New York, pp. 80–87.

Ulehlová, B., 1978b. Decomposition processes in the fishpond littoral. In: D. Dykyjová and J. Květ (Editors), Pond Littoral Ecosystems. Structure and Functioning. Springer, New York, pp. 341–353.

Ulehlová, B. and Přibil, S., 1978. Water chemistry in the fishpond littoral. In: D. Dykyjová and J. Květ (Editors), Pond Littoral Ecosystems. Structure and Functioning. Springer, New York, pp. 126–140.

U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020, 430 pp.

Webster, J.R. and Simmons, G.M., 1978. Leaf breakdown and invertebrate colonization on a reservoir bottom. Verh. Int. Ver. Limnol., 20: 1587–1596.