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**Distribution of *Lemnaceae* in the region of Istria (Istra)
and first discovery of flowering
Wolffia arrhiza (L.) Horkel ex Wimm. in Yugoslavia**

Verbreitung der *Lemnaceae* in Istrien (Istra) und die
erste Entdeckung blühender Pflanzen von
Wolffia arrhiza (L.) Horkel ex Wimm. in Jugoslawien

von

Bozidar Krajncić

1. INTRODUCTION

After physiological studies of *Lemnaceae* were carried out in the region of Slovenia (KRAJNCIĆ 1976, KRAJNCIĆ and DEVIDÉ 1979, 1980) and North Croatia (KRAJNCIĆ and DEVIDÉ 1981a,b), they were extended into the region of Istria.

In literature there is very little data on the habitat of *Lemnaceae* in the Istrian area (FIORI 1923-1925, ROSSI 1930 and KRAJNCIĆ 1976).

FIORI (1923-1925) mentions in his enumeration of habitats of *Wolffia arrhiza* in Italy, some habitats in Istria, but without its description. ROSSI (1930) mentions one habitat of *Lemna gibba* near the port of Plomin.

KRAJNCIC (1976) describes sites of *Lemna minor* (Raven) and *Lemna gibba* (Nova vas, Raven and Padna) in the region of Slovene Istria. According to KANDELER (1979), flowering *Wolffia arrhiza* plants have been found on only one site in Europe, in Northern Hither Caucasus by BENKOVA (1957).

2. METHODS

Studies of stagnant waters (ponds) in Istria were carried out in the months June, July and September in 1981 to 1988.

With local people aiding in the search for ponds, stagnant waters in almost all parts of Istria were investigated. The pH was measured by means of Pehanon indicator strips (Mackerey-Nagel & Co., Germany) and the portable electro-chemical pH meter MA5721 (Iskra, Yugoslavia).

3. RESULTS

In the years 1981-1988 several physiologically different clones of three *Lemnaceae* species were found in the region of Istria:

1. *Lemna minor* L., which is generally distributed in stagnant waters and only found in northern Istria at the previously described habitat, Raven (KRAJNCIČ 1976).
2. *Lemna gibba* L. Besides the localities published so far, 23 habitats have been found in the region of Istria (Fig. 1): Markoviči, Vižinada, Crklada, Prhati, Praščari, Ladroviči, Bonaci, Tinjan, Radmani, Flengi, Barat, Antončiči, Mrgani, Zamudiči, Kloštar, Maraškini, Vlašiči, Krusvari, Kukurini, Balabani, Šumber (2 habitats), and Klapčiči.
3. *Wolffia arrhiza* (L.) Horkel ex. Wimm. Beside FIORI's (1923-1925) mention of Istria without exact locations, 14 Istrian habitats were discovered (Fig. 1): Markoviči, Vižinada, Crklada, Prhati, Ladroviči, Bonaci, Radmani, Flengi, Barat, Antončiči, Mrgani, Zamudiči, Kloštar and Maraškini.

In all years of field research in Istria, flowering *L. gibba* were found at most habitats in June and July.

Flowering plants of this species were also found in September (1985 and 1986), only at the sites in Zamudiči, Maraškini and Vlašiči.

A larger number of flowering *Wolffia arrhiza* were found at sites in Vižinada

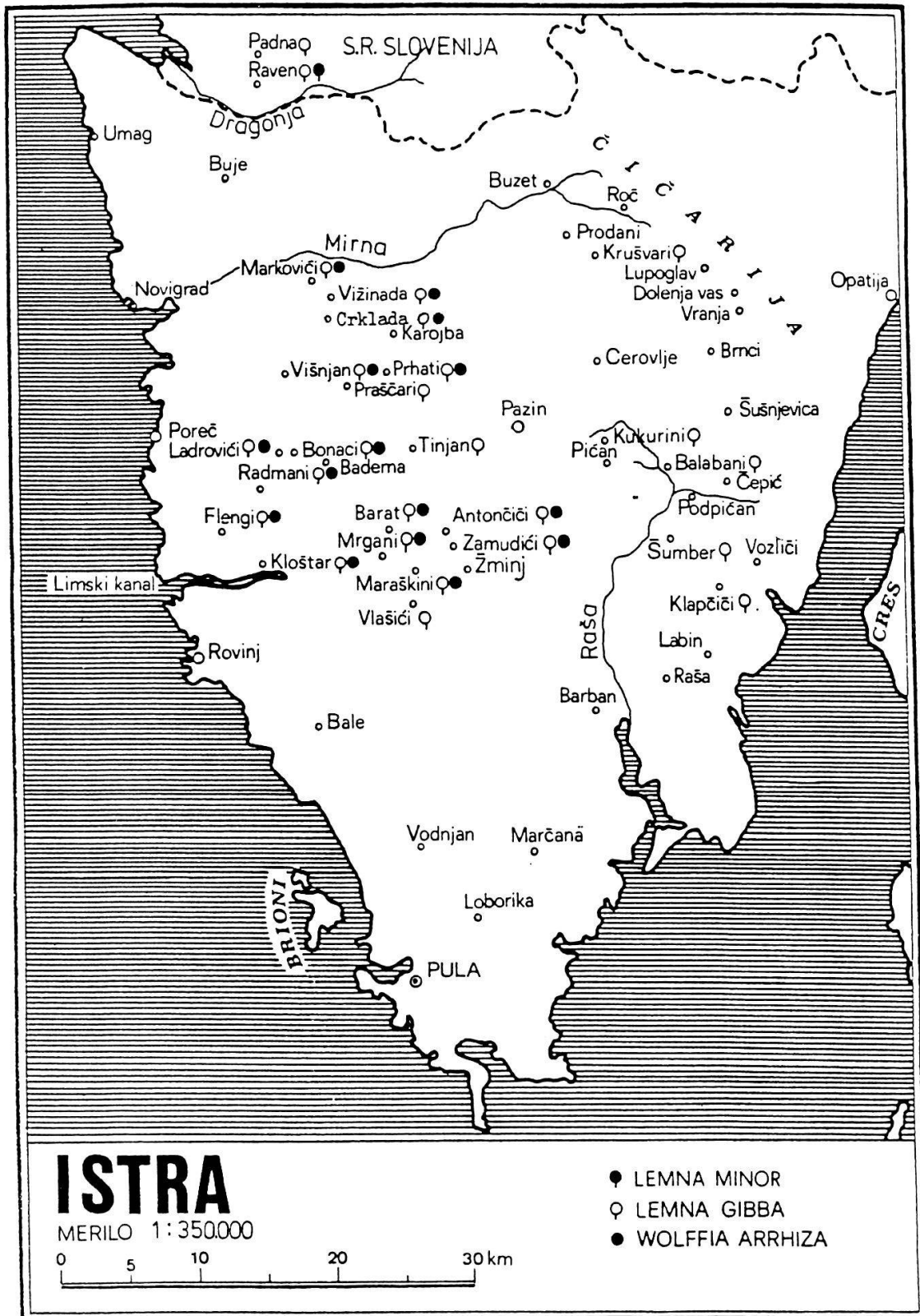


Fig. 1. Distribution of *Lemnaceae* in the region Istria.
Verbreitung von Lemnaceae in Istrien.

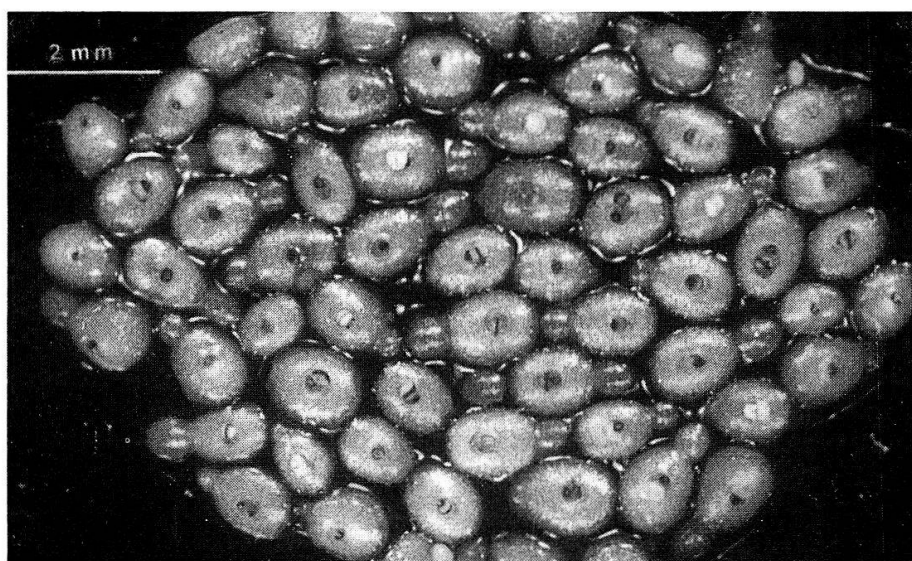


Fig. 2. Flowering plants of *Wolffia arrhiza* from the Vruljak pond (Vizinada).
Blühende Wolffia arrhiza im Vruljak Teich (Vizinada).

and Markovići only in September (Fig. 2), in all years from 1981 to 1988 (except 1986 because of drought) .

Description of discovered habitats

1. **Markovići:** a small village 1-2 km NW of Vižinada. About 100 m southward is a pond named Markoviceva loka (10x20 m), with *Lemna gibba* and *Wolffia arrhiza*. The pH of the water was 7.1-7.7 (measured on September 16-24, 1981-1988). In a succession of eight years (1981-1988, safe 1986) flowering *Wolffia arrhiza* were found at this site every year in September.
2. **Vižinada:** 8 km E of Novigrad. In Božje polje, 150 m NE of the cemetery are two ponds with *Lemnaceae*: the first one (5x6 m) with *L. gibba*, the second one (10x15 m), named Vruljak, with *L. gibba* and *W. arrhiza*. Water pH in both ponds was 7.2-7.8 (measured on September 15-24, 1981-1988). In Vruljak many *W. arrhiza* plants were flowering from September 15-24, 1981-1988, except 1986 (Fig. 2).
3. **Crklada:** a small village 1.5 km S of Vižinada. By the farm of Edi Ritoš (Crklada No. 25), is a pond (7x10 m) with luxuriously growing *W. arrhiza* and *L. gibba*. Water pH was 7.4-7.6 at various parts of the pond on September 13, 1988.
On September 13, 1988, flowering *L. gibba* plants first discovered by the author in Yugoslavia, Istria: on September 4, 1985, at the habitats in Vlašići and Maraškini; on September 6, 1986, in Antončići and Zamudici, and on September 9, 1987, in Barat, were also found at this habitat.
4. **Prhati:** a village 4.5 km SW of Karojba. From the asphalt road from Višnjani to Karojba, a macadamized road turns right 5 km before Karojba leading directly to Dikliče. After 40 m, a left turn leads to the village Prhati. Twenty meters SW of the house of Bruno Perkat (Prhati No. 1), is the largest habitat of *Lemnaceae* found in Istria so far (30x30 m), with a rich growth of *L. gibba* and *W. arrhiza*. Water pH measured on September 7, 1983, in various parts of the pond was 6.8-6.9.

5. **Prascari:** a village 4-5 km E of Višnjan. On the asphalt road from Vizinada to Baderna, 1 km S of the intersection with Višnjan-Karobjba road, is a macadamized left turn leading to Prascari. After 1 km, 200 m before Praščari, is a macadamized right turn leading after 150 m directly to a pond (20x20 m) with rich growth of *L. gibba*. Water pH measured on September 7, 1983, was 6.6-6.7.
6. **Ladrovići:** a small village about 9 km SE of Poreč and 2 km E of Žbandaj. Thirty meters N of the house of Martin Radolovic (Ladrovići No. 2), lying between the rocks, is a pond (5x20 m) with *L. gibba* and *W. arrhiza*. According to the locals, it is more than 100 years old. Water pH measured on September 17, 1982, was 6.9.
7. **Bonaci:** a small village about 10 km SE of Poreč and 1 km E of Ladrovići. From the home of Vitorio Bonaca (Bonaci No. 2), a macadamized road leads to the right of the road, about 40-50 m from the house, to a pond (15x20 m) with *L. gibba* and *W. arrhiza*. Water pH measured on September 18, 1982, was 7.1.
8. **Tinjan:** 12 km SW of Pazin. In the region of Tinjan there are two ponds with *L. gibba*: the first one (3x4 m), in a crevice 50 m below the church. Water pH measured on September 17, 1982, was 6.7. The second one (10x15 m), named Rupa, is about 1 km from Tinjan on the left of the macadamized road leading from Tinjan to Muntrilj. Water pH measured on September 16, 1982, was 6.6.
9. **Radmani:** a small village between Dračevac and Zbandaj, about 8 km SE of Poreč. On the left of the asphalt road Dračevac-Radmani, 20 m before the sign Radmani, is a pond (30x40 m) with *L. gibba* and *W. arrhiza*. In contrast to the other habitats discovered in Istria, only a small number of *Wolffia arrhiza* were found among *L. gibba*. Water pH measured on September 23, 1981, was 7.1.
10. **Flengi:** a village 5 km NE of Vrsar. On the left of the asphalt road Gradina-Flengi, 5 m before the sign of Flengi, is a pond (20x10 m) with *L. gibba* and *W. arrhiza*. Water pH measured on September 23, 1982, was 7.3.
11. **Barat:** a village 4-5 km NW of Kanfanar. On the right of the asphalt road Lovrač-Barat, 100 m before the farm of Mario Fariš (Barat No. 32), is a pond (15x15 m) with *L. gibba* and *W. arrhiza*. Water pH in the various parts measured on September 9, 1987, was 6.9-7.0.
12. **Antončiči:** a small village 3 km NW of Zminj. In the center of the village, opposite the farm of Fosko Križman (Antončiči No. 8) and by the crossroads Pifari-Antončiči-Žminj, is a pond (10x8 m) with *L. gibba* and *W. arrhiza*. Water pH in the various parts measured on September 6, 1986, was 6.7-6.8.
13. **Mrgani:** a village 6 km NW of Kanfanar on the new asphalt road between Dvigrad and Červari. In Mrgani are three ponds with *W. arrhiza* and *L. gibba*: On the right of the asphalt road leading from Mrgani to Dvigrad is the pond Voskuruš (15x20 m), to the left are the ponds Puč (10x15 m) and Špinjovica (15x15 m). Water pH measured on September 9, 1987, was 7.2 in Voskuruš, 6.9-7.0 in Puč and Špinjovica. According to the village elders, *Lemnaceae* have been growing in these ponds for more than sixty years.
14. **Zamudići:** a small village 2.5 km SW of Žminj. On the left of the macadamized road from Žminj to Pifari, opposite the farm of Marija Bančić (Zamudići No. 31) is a pond (6x6 m) with *L. gibba* and *W. arrhiza*. Water pH in the various parts measured on September 6, 1986, was 5.8-5.9. *L. gibba* was flowering on September 6 and 17, 1986.
15. **Kloštar:** a village 1-2 km N of the Lim Fjord and 8 km SE of Vrsar. In the middle of the village, near the house of Peter Mendica (Kloštar No. 5), is a pond (40x30 m) with *L. gibba* and *W. arrhiza*. Water pH measured on September 23, 1981 was 7.2. A few *W. arrhiza* were flowering on September 23, 1981.
16. **Maraškini:** a small village 4 km W of Žminj. By the crossroads with the macadamized road leading to Švogar, 70 m N of the farm of Dario Banka (Maraškini No. 23), is a pond (12x8 m) with *L. gibba* and *W. arrhiza*. Water pH measured in various parts on September 4, 1985, was 7.0-7.1. At this site the author saw for the first time flowering *L. gibba* in September.

17. **Vlašići**: a small village 4 km W of Žminj and 2 km E of Kanfanar. Next to the motor road, opposite the farm of Ivan Krizman (Vlašići No. 27), is a pond (7x10 m) with *L. gibba*. Water pH measured in various parts on September 4, 1985, was 6.8-6.9. On September 4, 1985, many *L. gibba* plants were flowering.
18. **Krušvari**: 12 km SE of Buzet. After the village, driving towards Cerovlje, a right turn leads to Račiški breg. About 150 m from the mentioned crossroads, on the left of the road leading to Račiški breg, is a pond (5x3 m) with *L. gibba* among reed (*Typha*). Water pH measured on September 23, 1981, was 6.7.
19. **Kukurini**: 3 km N of Pican. 300 m from the house of Anton Bacač (Kukurini No. 7), driving towards Pičan, on the hill by an abandoned stone hut, is a pond (5x2.5 m), named Kom-ešova lokva after his deceased owner, with *L. gibba* and with reed (*Typha*) along its edges. Water pH measured on September 17, 1982, was 6.7.
20. **Balabani**: about 5 km SW of Podpičan. On the left of the stony macadamized road Podpičan-Balabani, 50 m before Balabani, an old pond (12x7 m) is overgrown with *L. gibba* and reed (*Typha*) along its edges. Water pH measured on September 17, 1982, was 6.8.
- 21-22. **Šumber**: a 4 km long village. Two ponds with *L. gibba* were found: the first one (15x15 m), in the middle of the village by the farm of Anton Radovič (Šumber No. 40); the second one (10x15 m) at the end of the village towards the main road Podpičan-Pazin, near the farm of Tomaž Anton Radovič (Šumber No. 96). Water pH measured on September 8, 1984, was 6.6-6.7.
23. **Klapčiči**: a small village in a basin 1 km N of Nedeščina. In the middle of the village, near the farm of Anton Načinovič (Klapčiči No. 36) is a pond (15x15 m) with *L. gibba*. Water pH measured in various parts on September 9, 1984, was 6.6-6.7.

No *Lemnaceae* were found in the ponds in the surroundings of Umag, Buje, Buzet, Novigrad, Poreč, Bale, Vodnjan, Pula, Lobarika, Marčana, Barban, Raša, Labin, Šušnjevica, Vranje.

Lemnaceae do not grow in ponds with *Potamogeton natans* or *P. nodosus*.

4. DISCUSSION

According to FIORI (1923-1925), ROSSI (1930), KANDELER (1979), and LANDOLT (1986) this description of *Lemnaceae* habitats in the region of Istria is the first to be published. Therefore no comparison with data from other authors is possible.

Sites with flowering *W. arrhiza* are the first to be published from Yugoslavia, and according to KANDELER (1979), the second in Europe.

Flowering of *W. arrhiza* in September confirms the published laboratory results that *W. arrhiza* are long-short day plants in Yugoslavia (KRAJNČIČ and DEVIDÉ 1980, 1982b).

Flowering of *L. gibba* observed in June and July confirms the laboratory results that *L. gibba* are long day plants (KANDELER 1955, KRAJNČIČ and DEVIDÉ 1980, 1982b). Flowering *L. gibba* in September at sites in Zamudiči, Maraškini and

Vlasici confirm laboratory results (KRAJNČIĆ unpubl.) that some clones are quantitatively long day plants.

It was noted (as in Slovenia and northern Croatia), that *Lemnaceae* do not grow in ponds with *Potamogeton natans* or *P. nodosus*. This might be due to allelopathy.

SUMMARY

Twentythree hitherto unpublished habitats of *Lemnaceae* are described and represented in Fig. 1.

Lemna gibba occurs in all habitats, *Wolffia arrhiza* only in 14 habitats.

In a succession of several years (1981-1988) flowering *W. arrhiza* were discovered in September (Fig. 2). It is the first discovery of flowering *W. arrhiza* in Yugoslavia, and the second in Europe.

ZUSAMMENFASSUNG

Es werden 23 bisher noch nicht veröffentlichte Fundorte von *Lemnaceae* beschrieben und eingezeichnet (Fig. 1).

Lemna gibba kommt an allen Fundorten vor, an 14 davon auch *Wolffia arrhiza*.

In den aufeinanderfolgenden Jahren 1981-1988 wurden blühende *Wolffia arrhiza* immer im September entdeckt (Fig. 2). Das ist die erste Entdeckung blühender Pflanzen dieser Art in Jugoslawien und die zweite in Europa.

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