

DEVELOPMENTAL STAGES IN THE FLORAL BIOLOGY S.L. OF DUTCH NYMPHAEACEAE (NYMPHAEA ALBA L., NYMPHAEA CANDIDA PRESL, NUPHAR LUTEA (L.) SM.).

G. VAN DER VELDE

Laboratorium voor Aquatische Oecologie, Katholieke Universiteit, Toernooiveld, 6525 ED, Nijmegen

The development of labelled flowers of three species of Nymphaeaceae grown in outdoor concrete tanks situated near the university area, was followed by means of daily observations.

The duration of the prefloral, floral s.s. and postfloral stages is shown in *table 1*.

In the flower bud stage two substages can be recognized, viz. a stage, more than one day before anthesis, in which the buds show only their green sepals, and a stage, one day before anthesis, in which the tips show part of the white corolla (*Nymphaea*) or of the yellow parts of the sepals (*Nuphar*).

The stages of anthesis can be described briefly as follows: *Nymphaea* (both species): on the first day the stigmatic disc is free from the anthers (all unripe) and fills with stigmatic fluid; on the second day the inner rows of anthers are ripe and bend over the stigmatic disc (in *Nymphaea alba* the filaments of these anthers are bent down at acute angles; in *Nymphaea candida* they are curved over the stigmatic disc); the stigmatic disc is dry and during the next days the outer rows of anthers ripen, while at the last day of flowering the flower becomes semi-submerged.

During anthesis the flowers of both species are closed at night and open every day. After anthesis they close for the last time, float horizontally on the water surface for a number of days and then sink under water, where the fruit ripens. At a certain moment the ripe fruit bursts open and the seeds, enveloped by a membraneous aril with gas bubbles, float at the water surface. Subsequently they sink to the bottom after one day.

Nuphar: on the first day, the flower opens triangular and narrow, the stigmatic disc is often sticky, stigmatic rays are yellow and shiny, the anthers are all pressed against the stigmatic disc and unripe; the flower begins to exude a brandy odour and to produce nectar on the petals; on the second day, the outer rows of anthers bend away from the stigmatic disc; the stigmatic disc is dry, and during the next days more anthers from the inner rows bend away from the stigmatic disc and ripen, while the stigmatic rays become brown. During the whole anthesis period the flower has a brandy odour and produces nectar; the flowers do not close at night. During anthesis the flower is held by the peduncle above the water surface; after the last day of flowering the flower becomes semi-submerged

Table 2. Duration of several stages in the development from flower bud to seed in three Dutch Nymphaeaceae.

Stage	Nymphaea alba		Nymphaea candida		Nuphar lutea	
	days	av. (S.D.)	days	av. (S.D.)	days	av. (S.D.)
1. bud on/above the water surface	2-8	5(2.2) n=15	4-7	5(1.5) n=4	3-8	6.5(2.7) n=12
2. flowering	4-7	6(1.1) n=16	4-6	5(1.2) n=3	4-8	6 (1.3) n=11
3. period last flowering day - bursting fruit with ripe seeds	37-49	43(3.5) n=11	18-22	20(2.8) n=2	(31)-37-47	42 (3.7) n=5
with unripe seeds	33-37	35(2.8) n=2	1	1(0) n=1		
4. decomposing fruit (unripe seeds)	1-9	4(3.3) n=5				
bursting fruit (ripe seeds)/seeds or fruit parts at the water surface	1-3	1(0.6) n=11			1	1 (0) n=5

Table 2. Variation in the numbers of floral parts of Dutch populations of three species of Nymphaeaceae (rarely observed extremes in brackets).

Number of floral parts			
	<i>Nymphaea alba</i>	<i>Nymphaea candida</i>	<i>Nuphar lutea</i>
Sepals	4 (5,6)	4 (5)	5
Petals	16-27-(32) av. 22	(17)-20-31-(32) av. 24	12-21 av. 15
Stamens	(50)-60-120-(136) av. 89	(48)-60-90-(96) av. 74	81-165 av. 125
Carpels (stigmatic rays)	(10)-12-23-(28) av. 17	(7)-8-15-(16) av. 11	10-21 av. 16

and the fruit develops and ripens at the water surface. At a certain moment the fruit bursts and separate carpels containing seeds float at the water surface. Subsequently they sink to the bottom after one day.

The development of the flowers of the species of Nymphaeaceae studied suggests that all species are protogynous. The *Nymphaea* species are only day-flowering, while *Nuphar* is flowering day and night without any closing movement of the floral parts during anthesis. The variation in the duration of anthesis in the species studied seems to be due to the variation in ripening of the anther rows and is perhaps correlated with the variation in the numbers of stamens, which can vary greatly for different flowers (*table 2*).

The species studied all show a long duration of the male phase of the flowers (c.f. one day in *Nymphaea mexicana* Zucc., two days in other *Nymphaea* species studied in Texas (CAPPERINO & SCHNEIDER 1985). Since *Nymphaea mexicana* is considered to be primitive (see CAPPERINO & SCHNEIDER 1985) the extension of the male phase of the species considered here may be interpreted to be a further specialization.

REFERENCES

- CAPPERINO, M. E. & E. L. SCHNEIDER (1985): Floral biology of *Nymphaea mexicana* Zucc. (Nymphaeaceae). *Aquat. Bot.* 23: 83-93.