Phenology and co-existence of Agabus conspersus and A. nebulosus (Coleoptera, Dytiscidae) in SE England, with observations on mature larval leg chaetotaxy

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Carr, R.: Phenology and co-existence of *Agabus conspersus* and *A. nebulosus* (Coleoptera, Dytiscidae) in SE England, with observations on mature larval leg chaetotaxy. [Fenologi och samexistens hos dykarskalbaggarna *Agabus conspersus* och *A. nebulosus* i SO England, med beskrivning av larvernas benbehåring.] — Ent. Tidskr. 111: 39–43. Umeå, Sweden 1990. ISSN 0013-886x.

Data is provided on the larval development of the two predaceous water beetles *Agabus conspersus* (Marsham) and *A. nebulosus* (Forster) derived from observations undertaken at three temporary ponds in Kent (SE England) during the spring and early summer of 1988. Chemical analyses of water samples from the three ponds were carried out at the beginning of the period of study and are included as an indication of the habitat preference of each species. Larvae of both species were found together in one pond. Diagnostic characters in the leg chaetotaxy of third instar larvae of the two species are provided, based on examinations of material from Great Britain and in particular, the county of Kent.

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Agabus conspersus (Marsham) is generally recognised as a brackish water species usually occurring in salt marshes near the coast, whereas *A. nebulosus* (Forster) was hitherto considered a pond species found in gravel and clay pits with grassy edges, though also occurring in acidic areas in association with *A. unguicularis* (Thomson) and *A. affinis* (Paykull) (Balfour-Browne 1950).

The second and third instar larvae of both species have been described by De Marzo (1973), and Galewski (1980, 1986). Descriptions of the first larval instar are also given by De Marzo (1974) who provided diagnostic methods of separation based on the number of spiniform setae present on the femora of each species.

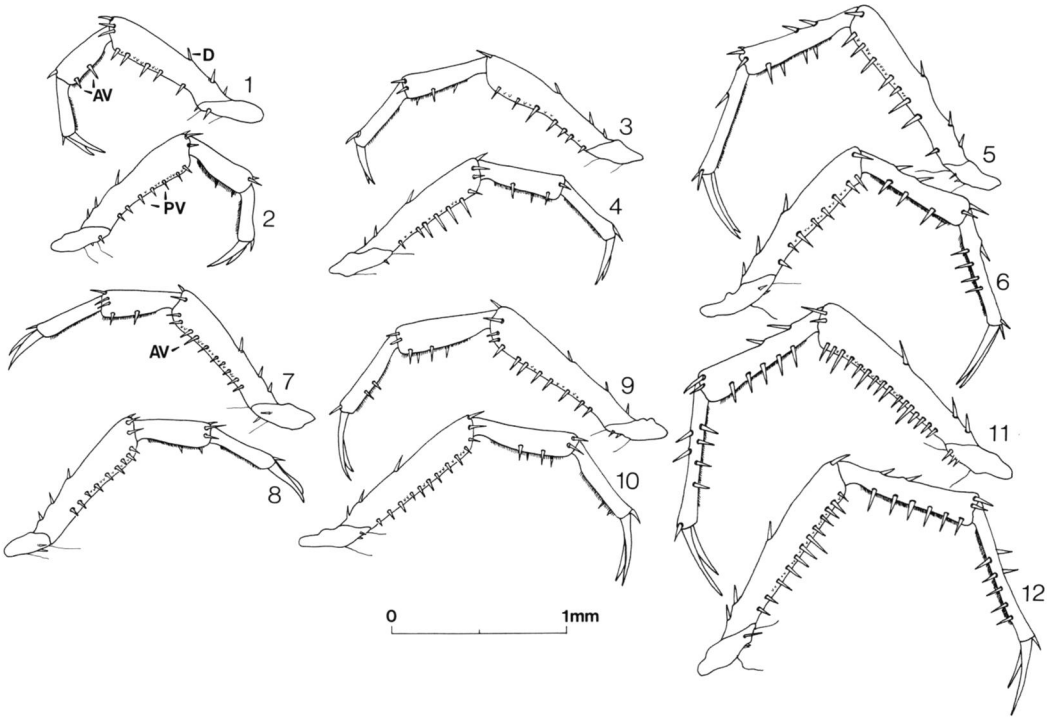
Galewski (1976) also commented on the greater number of setae present on the ventral margin of the mid and hind tarsi and tibiae in third instar *A. nebulosus* larvae, though his methods of distinguishing the two species rely on relative and gradational characters, for example the head shape and neck, which are somewhat variable according to the maturity of the cuticle.

Methods and material

Observations commenced in mid April, 1988, at Pond A. This pond is one of a series of open temporary ponds within close proximity to the sea at Graveney Marshes (National Grid Reference TR 061647). The pond was roughly circular and about 4 m across. At the commencement of the study it contained approximately 0.3 m of water which had probably accumulated during the preceding winter months. The dominant vegetation surrounding the pond was *Scirpus maritimus* L. Visits were made to the pond on a monthly basis until late July when only 0.05 m of water was present.

The water level of the pond had remained stable throughout the study period until early June, by which time the level had dropped to 0.15 m. From early June until late July the drying out process rapidly accelerated, no doubt as a result of evaporation due to increased temperatures. When visited in mid August, the pond was completely dry.

Pond B is located on exposed grazing land at Wouldham Marshes (N.G.R. TQ 713656). At the



Figs 1–12. *Agabus*, legs without coxae of third instar larva. Position of dorsal (D), anteroventral (AV) and posteroventral (PV) spiniform setae indicated. – 1–6. *A. conspersus* (Marsh.). – 7–12. *A. nebulosus* (Forst.). – 1, 2, 7, 8. Fore leg. – 3, 4, 9, 10. Mid leg. – 5, 6, 11, 12. Hind leg. – 1, 3, 5, 7, 9, 11. Anterior aspect. – 2, 4, 6, 8, 10, 12. Posterior aspect.

Agabus, ben utan höft av fullväxt larv. – 1, 2, 7, 8. Framben. – 3, 4, 9, 10. Mellanben. – 5, 6, 11, 12. Bakben.

time of the survey this was a shallow grassy pond about 8 m across and approximately 0.3 m deep, situated within the flood plain of the River Medway which is tidal at this point. Observations commenced at this pond in late April 1988 and monthly visits were made until the pond became dry in early July.

The water level of this pond also remained stable until early June, when a reduction in level of about 0.05 m had occurred, the difference in level being particularly evident around the periphery of the pond which had been frequented by the larvae of *A. nebulosus*. The pond became completely dry by early July. Vegetation surrounding the pond included *S. maritimus* and a few *Alnus* saplings.

Pond C was formed in a temporary shallow ditch about 10 m long and 1.5 m wide at Iwade (N.G.R. TQ 905687). This ditch is also located within an area of open grazing land near the coast but is not connected to the main ditch system which is obviously of a brackish nature. Water in the ditch was 0.4 m deep when observations commenced in early May.

The drying out process in the pond was more gradual than in the preceding two waterbodies. A 0.2 m reduction in level had occurred by mid May followed by a further drop of 0.1 m in early June. The pond was completely dry in late June. No significant vegetation surrounded the pond other than grasses which had been cropped short by the grazing of cattle. Owing to the late start of observations on this pond, visits were made on a fortnightly basis until the pond became dry.

Semi-quantitative samples were taken at each of the three ponds with a hand net of 20 apertures to the inch and the frequency of each species was recorded.

In 1988, larval development had already commenced in each of the three waterbodies prior to

Tab. 1. Number of spiniform leg setae in third instar larvae of *Agabus conspersus* (Marsh.) and *A. nebulosus* (Forst.). Position of setal series abbreviated as: (D) dorsal, (AV) anteroventral, and (PV) posteroventral.

Antal tagglika borst i olika rader på fram-, mellan- och bakbenen av fullväxta larver av *Agabus conspersus* och *A. nebulosus*.

		conspersus			*nebulosus*		
Setal series		Fore	Mid	Hind	Fore	Mid	Hind
Femur	D	2–3	3	2–3	2–4	2–4	3–4
	AV	5–6	6–8	5–8	8–10	10–12	11–14
	PV	6–8	6–8	7–8	7–10	7–10	12
Tibia	D	–	–	1–2	–	–	2
	AV	2	1	1	2	2–4	4–5
	PV	–	1–3	3–5	–	1–3	5–6
Tarsus	D	–	–	1–2	–	–	2–3
	AV	–	–	0–1	–	0–2	2–4
	PV	–	–	3–5	–	0–1	4–6

their recognition as being breeding centres of the two species. The survey had been intended to continue into the following year but due to an exceptionally dry autumn in 1988, none of the ponds became waterlogged and each remained dry throughout the winter and spring of 1989.

The larvae of *A. conspersus* and *A. nebulosus* were identified on the basis of the descriptions by Galewski (1980) and De Marzo (1973, 1974), and preserved in 70 % ethanol. The three successive larval instars have been abbreviated as L1–L3.

On the basis that only *A. conspersus* adults occurred in Pond A and only one *A. nebulosus* adult was found in Pond B, it was noted that the larvae could be easily separated on an examination of the leg setation using the system introduced by Nilsson (1986c, 1987) (Figs 1–12). The L2 and L3 of both species were encountered in Pond C.

A detailed study was made of the leg chaetotaxy on seven L3 of *A. conspersus* from Pond A and on six L3 of *A. nebulosus* from Pond B. In addition, single L3 from Littlebrook and Headcorn (Kent) were examined and determined respectively as *A. conspersus* and *A. nebulosus*. Five L2 and one L3 of *A. nebulosus* from Scotland were also examined.

Drawings of the larval leg chaetotaxy were made from dissected material mounted on slides. The studied material is preserved in the collection of the author.

Tab. 1 summarises the diagnostic characters used to separate the two species. As the number of spines in some of the series show intraspecific variation, it is necessary to examine all the legs. The most reliable characters appear to be the number of anteroventral spines on the fore, mid, and hind femora, mid and hind tibiae, and hind tarsus, all of which number more in *A. nebulosus* than in *A. conspersus*.

Results

Tab. 2 refers to the presence of adult beetles and larvae in the studied ponds.

On commencement of observations at Pond A in April, adults of *A. conspersus* were present with all three larval instars. Teneral adult beetles were present in the pond from June until late July prior to the dry phase of the pond. Associated species of Dytiscidae which bred in Pond A were *Laccophilus minutus* (L.), *Coelambus parallelogrammus* (Ahrens), *Rhantus frontalis* (Marsh.) *Colymbetes fuscus* (L.) and *Dytiscus circumflexus* Fabr. All larval instars of *A. nebulosus* were present in Pond B during May and a single teneral adult was found in early June. Other breeding species of Dytiscidae in this pond included *Hydroporus planus* (Fabr.), *Agabus bipustulatus* (L.), *R. frontalis, R. suturalis* (MacLeay), *C. fuscus,* and *D. marginalis* L. L2 and L3 instars of both *A. conspersus* and *A. nebulosus* were found in Pond C throughout May and L3 only in early June. Adults of both species were present in the pool during early June.

In Pond C, 1 L2 and 16 L3 of *A. nebulosus* and 2 L2 and 4 L3 of *A. conspersus* were collected. It would therefore appear that *A. nebulosus* was dominant with A. conspersus as a peripheral species. The chemical analyses of water samples from each of the ponds at the commencement of the periods of study (Tab. 3) imply that conductivity and chlorinity may be the limiting factors.

Tab. 2. Seasonal occurrence of adults and larvae of *Agabus conspersus* (Marsh.) and *A. nebulosus* (Forst.) in the three studied ponds in Kent in 1988. L1–L3 denote the three successive larval instars, and adults are classified as mature (M) or teneral (T). Relative abundance is given as: (–) absent, (o) occasional, five or less individuals per visit, and (f) frequent, more than five individuals per visit.

Månatlig förekomst av vuxna (M = mogna, T = nykläckta) och larver (L1–L3 anger olika larvstadier) av *Agabus conspersus* och *A. nebulosus* i tre dammar i Kent 1988. Antal individer per besök ges som: (–) 0, (o) 1–5, (f) 6 och fler.

	Month/Månad			
Species and pond	April	May	June	July
conspersus				
Pond A				
Adults, M	o	f	f	f
Adults, T	–	–	o	f
L1	f	f	f	–
L2	o	f	f	–
L3	f	f	f	–
Pond C				
Adults, M		–	o	
L2		o	o	
L3		o	o	
nebulosus				
Pond B				
Adults, T	–	–	o	–
L1	–	f	–	–
L2	o	f	–	–
L3	–	f	o	–
Pond C				
Adults, M		–	o	
L2		o	–	
L3		o	f	

Chironomid larvae and Cladocera were abundant in all three ponds during the period of study. It is likely that these constitute the prey of the *Agabus* larvae (Nilsson 1986b). Conditions were favourable for the development of micro-organisms in both ponds B and C, the water having been contaminated by cattle. This condition appears to be favourable for the development of *A. nebulosus*, a similar situation being observed at an upland loch at Ailsa Craig, Ayreshire (Scotland), by G.N. Foster (pers. comm.). In this instance the pool had become nutrient rich due to the effects of gull droppings, providing a suitable habitat for the development of *A. bipustulatus, A. nebulosus,* and *C. fuscus* larvae.

Tab. 3. Water analysis from three ponds in Kent during the commencement of the period of study in 1988. All values except pH given as parts per million.

Vattnets pH, konduktivitet, alkalinitet, hårdhet och kloridinnehåll i de tre studerade dammarna i Kent vid undersökningens början.

	Pond A	Pond B	Pond C
pH	7.8	7.1	7.7
Conductivity	8400	900	1300
Total Alkalinity	900	460	640
Total Hardness	1380	728	480
Chloride	3720	48	680

Discussion

The information obtained from the studied ponds is not contradictory to Nilsson's (1986a) view that *A. conspersus* and *A. nebulosus* have a "Type 1" life cycle. To this group belong univoltine spring breeders which have summer larvae and over-winter as adults.

Development of the larvae appears to be rapid following an increase in temperature and extended daylengths prior to the commencement of the dry phase of the pools. A similar life cycle strategy was observed in *A. labiatus* (Brahm) by the author in SE England (Carr 1989). *A. conspersus* and *A. nebulosus* belong to the group of temporary water breeders, a typical community in SE England also including *H. planus, A. bipustulatus,* and species of *Coelambus, Rhantus,* and *Dytiscus.*

With the exception of *A. bipustulatus*, which has a flexible reproductive period, the remaining species can all be categorised as belonging to the Nilsson (1986a) "Type 1" life cycle group.

The limited information obtained from the study indicates that the habitat requirements of *A. conspersus* and *A. nebulous* for breeding purposes can overlap. With increased chlorinity and conductivity, the temporary water community apparently loses such species as *H. planus, A. bipustulatus,* and *A. nebulosus.* Members of the genera *Coelambus, Rhantus,* and *Dytiscus* are replaced with species contained within the same genera that display a preference for brackish conditions. Interestingly, *C. fuscus* appears to be capable of breeding in conditions of high chlorinity as well as in freshwater.

Whereas *A. conspersus* is clearly halophilous and restricted to waters of high chlorinity, *A. nebulosus* has apparently a tolerance of chlorinity not

recognised by earlier authors (Balfour-Browne 1950, Galewski 1976) and may—in SE England at least—be regarded as haloxenous or salt-tolerant, along with *H. planus*. The preference of the latter species for high chlorinities was observed by Cuppen (1986) in the Netherlands.

The incidence in teneral adults of *A. conspersus* and *A. nebulosus* during the period of study is broadly in keeping with the observations of Balfour-Browne (1950) who took "recently emerged imagines" of *A. nebulosus* in May, June, August and September, and those of *A. conspersus* from June to August and in October. As is indicated in Tab. 2, teneral specimens of *A. conspersus* occurred in Pond A during June and July. A single teneral specimen of *A. nebulosus* was present in Pond B during June.

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Sammanfattning

Förekomsten av larver av de båda närstående dykararterna *Agabus conspersus* (Marsham) och *A. nebulosus* (Forster) studerades i tre dammar i Kent, SO England. Larver påträffades från april till juni, och i en av dammarna fanns båda arterna tillsammans. De båda arternas habitatval överlappade, med *A. conspersus* i dammar med högre och *A. nebulosus* i de med lägre salthalt. För båda arterna beskrivs det sista larvstadiets benbehåring i detalj, och det anges hur man med hjälp av denna kan särskilja arterna.

Aricia artaxerxes efterlyses!

Vi undersöker de båda närstående blåvingearterna *Aricia agestis* och *A. artaxerxes* och bl a med enzymelektrofores studerar vi de genetiska skillnaderna mellan olika populationer. Trots att vi hållit på några år har vi inte lyckats få tag i någon population av *A. artaxerxes* från svenska fastlandet. Vi vore därför tacksamma om ni, som vet någon plats i Sverige (ej Öland–Gotland), där man utan större svårighet kan samla in 30–40 individer av denna art, hör av er till oss.

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