

A review of the genus *Arion* in Belgium (Mollusca, Pulmonata)

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Abstract

The paper briefly reviews the present state of the systematic knowledge of the eight *Arion* species hitherto known to occur in Belgium.

Key-words: Mollusca; Pulmonata; *Arion*; systematics; Belgium.

Résumé

Cet article donne un bref aperçu de l'état actuel de nos connaissances de la systématique des huit espèces du genre *Arion* appartenant à la faune belge.

Mots-clefs: Mollusca; Pulmonata; *Arion*; systématique; Belgique.

Introduction

The genus *Arion* FÉRUSSAC, 1819 is a systematically confused group of terrestrial slugs, which are native in Europe. Currently, 25 to 30 species may be recognised and at least eight of these are known to occur in Belgium, viz. *Arion (Arion) ater* (LINNAEUS, 1758) s.l., *A. (Mesarion) subfuscus* (DRAPARNAUD, 1805) s.l., *A. (M.) lusitanicus* MABILLE, 1868, *A. (Kobeltia) hortensis* FÉRUSSAC, 1819 s.s., *A. (K.) distinctus* MABILLE, 1868, *A. (K.) intermedius* NORMAND, 1852, *A. (Carinarion) circumscriptus* JOHNSTON, 1828 and *A. (C.) silvaticus* LOHMANDER, 1937. The present paper aims to provide a brief account of these species.

Supraspecific systematics

Until recently, most authors divided the genus *Arion* into five subgenera, viz. *Arion* FÉRUSSAC, 1819 s.s., *Mesarion* HESSE, 1926, *Kobeltia* SEIBERT, 1873, *Microarion* HESSE, 1926 and *Carinarion* HESSE, 1926. In fact this system is only a slightly modified version of the original proposals of COLLINGE (1897) and HESSE (1926). However, QUICK (1960), FORCART (1965), BOATO et al. (1983), GITTENBERGER et al. (1984) and VAN GOETHEM (1984, 1987) have doubts about this classification. WALDÉN (1976), for example, suggested to include *A. intermedius* in *Kobeltia*, so that *Microarion* would become a subjective junior synonym of *Kobeltia*. Later on, BEESON (1960), BURCH (1965), BACKELJAU (1985a) and BACKELJAU & DE WINTER

(1987) provided chromosomal and electrophoretic evidence in favour of this suggestion. In accordance with the latter authors I consider here only four subgenera. BACKELJAU & DE WINTER (1987), however, also observed that these four subgenera can be grouped two by two, viz. *Arion* s.s. and *Mesarion* at one hand, and *Kobeltia* and *Carinarion* on the other. Yet, no taxonomic status has been attached to these groupings. Moreover, VAN GOETHEM (1984, 1987) and BACKELJAU & DE WINTER (1987) even wondered whether the four "subgenera" should all have the same taxonomic rank. A more detailed, yet still preliminary, account of the infrageneric systematics of *Arion* is now in preparation.

Arion (Arion) ater s.l.

This complex consists of at least two nominal species, viz. *A. ater* s.s. and *A. rufus* (LINNAEUS, 1758), the systematics of which are still far from settled. So it is not excluded that some nomenclatural and taxonomic rearrangements will become necessary. Nevertheless, hitherto only the species commonly referred to as *A. rufus* was mentioned for Belgium (e.g. ADAM, 1960). Yet, MARQUET (1982) suggested that also *A. ater* s.s. might belong to our fauna. Recently, this assumption has been investigated by RISCH (1987), who concluded that the vast majority of Belgian *A. ater* s.l. specimens belong to *A. rufus*. Yet, in addition to the large number of *A. rufus*, RISCH (1987) also noted four doubtful specimens which perhaps could be assigned to *A. ater* s.s. Thus, the actual occurrence of the latter species in Belgium needs further confirmation. Finally, the most surprising result of RISCH (1987) and RISCH & BACKELJAU (1989) was the observation that in Belgium *A. ater* s.l. has been regularly confused with *A. lusitanicus*, a species which will be dealt with elsewhere in this paper.

Arion (Mesarion) subfuscus s.l.

Some authors have suggested that *A. subfuscus* in fact refers to a complex of cryptic species, while others have

tried to divide the species into several forms. No one so far, however, has been able to separate and define these species or forms conveniently. Yet, recent electrophoretic analyses have provided evidence, which enabled McCracken & Selander (1980) to split North-American *A. subfuscus* s.l. into two distinct genetic types. One of these is highly polymorphic and seems to reproduce by allogamy. The other one consists of at least three monomorphic genetic strains, which are assumed to reproduce uniparentally. Similarly, Foltz et al. (1982) reported two genetic types in British *A. subfuscus* s.l. One of these appeared to be identical to the outcrossing American form. The other one, however, was different from any of the American types. An electrophoretic survey of *A. subfuscus* s.l. in continental Europe indicates that in Belgium and the Netherlands this species also consists of at least two distinct electrophoretic forms (Backeljaeu & De Winter, in prep.). For the time being they are labelled as the S- and F-type, according to the relative mobilities of their phosphoglucosyltransferase electromorphs (S=slow and F=fast) as revealed by polyacrylamide gel electrophoresis (Backeljaeu & De Winter, 1987: fig. 4). However, the taxonomic status of these genetic types, as well as their relationships with the forms demonstrated in Great Britain and North America, require further research.

Arion (Mesarion) lusitanicus s.l.

This is another complex which, at least in Britain, consists of two distinct species, viz. *A. lusitanicus* s.s. and *A. flagellus* Collinge, 1893 (see Davies, 1987; Risch & Backeljaeu, 1989). Consequently, a review of *A. lusitanicus* s.l. in continental Europe is badly needed, especially since it may be expected that in southern Europe several other species may belong to this group (Backeljaeu, 1989; Risch & Backeljaeu, 1989). This situation is further complicated by the fact that *A. lusitanicus* is also commonly confused with *A. ater* s.l., even though the anatomical differences between both complexes are quite obvious (Risch & Backeljaeu, 1989). Finally, the subgeneric allocation of *A. lusitanicus* is also still debated. Traditionally, the species has been assigned to *Arion* s.s. Recently Davies (1987) confirmed this, but stated simultaneously that the very similar *A. flagellus*, on the contrary, would be a *Mesarion*. For the time being, however, I'm not inclined to follow this opinion and I prefer to assign both *A. lusitanicus* and *A. flagellus* to *Mesarion*. This thesis seems to be supported by the structure of the oviduct and ligula in these species. A chromosomal analysis could be decisive here, since arionid chromosome numbers may be correlated with the "subgenera" (Backeljaeu & De Winter, 1987; Risch & Backeljaeu, 1989).

The occurrence of *A. lusitanicus* in Belgium was

recently investigated by Risch & Backeljaeu (1989) who found that previous Belgian authors referred the species to as *A. rufus*. Hitherto *A. lusitanicus* is known from 21 Belgian 10 x 10 km U.T.M. squares. Since the oldest sample dates from 1973, it seems as if the species is a relatively recent immigrant.

Arion (Kobeltia) hortensis s.l.

This is undoubtedly the best studied arionid species complex in Europe, even though much work still needs to be done with respect to the situation in southern Europe. Yet, in northwestern Europe, the complex consists of at least three distinct species, viz. *A. hortensis* s.s., *A. distinctus* and *A. owenii* Davies, 1979 (see Davies, 1977, 1979; Backeljaeu, 1981, 1985a, b, 1987a; De Wilde, 1983, 1986; De Winter, 1984; Backeljaeu & Marquet, 1985; Backeljaeu & Van Beeck, 1986).

A. hortensis s.s. and *A. distinctus* have also been demonstrated in Belgium (Backeljaeu, 1981; De Wilde 1983; Backeljaeu & Marquet, 1985). Yet, even though hitherto more than 2500 Belgian specimens of *A. distinctus* have been checked anatomically, the genital dimorphism of this species, as originally reported by Davies (1977, 1979), has not been observed in Belgium. Thus for the time being only *A. distinctus* with a bipartite oviduct has been positively identified in our country. *A. distinctus* with a tripartite oviduct, on the contrary, has been recorded in the Netherlands, West Germany, France and the British Isles, where it lives sympatrically with the bipartite type (Davies, 1977; De Winter, 1984). Finally, despite intensive faunistic research in northwestern Europe, no one so far has been able to demonstrate the existence of *A. owenii* in continental Europe. The record of *A. owenii* from northwestern Germany by Zeissler (1981) should indeed be considered erroneous (Backeljaeu et al., 1988). Hence *A. owenii* appears to be endemic in the British Isles (see also Backeljaeu, 1988; Backeljaeu et al., 1988) and is thus hitherto not known from Belgium.

Arion (Kobeltia) intermedius

Backeljaeu (1986) clearly demonstrated that Normand (1852) described this species as an *Arion* and not as a *Limax* as has often been stated by other authors. Until recently *A. intermedius* was considered to be the least problematic species in the genus. Yet, the electrophoretic analysis of McCracken & Selander (1980) and the parallel investigations on *Carinarion* spp. by Backeljaeu et al. (1987), suggest that *A. intermedius* should perhaps be considered as an agamospecies complex. Indeed, although the species is polymorphic at several enzyme loci, it does not show any trace of heterozygosity. This may indicate that *A. intermedius* reproduces uniparentally, something which is further

supported by the fact that its spermatophore is unknown, that its copulation has never been observed and that individuals reared in isolation still produce a viable offspring (CHICHESTER & GETZ, 1973). Evidently, a polymorphic, but uniparental species will inevitably produce a series of monomorphic genetic strains. BACKELJAU et al. (1987) discuss the systematic consequences of the existence of such genetic strains in more detail. In any case, even though the electrophoretic survey of European *A. intermedius* is still in its initial phase, I already recorded three genetic strains of this species in Belgium (BACKELJAU, unpubl. data). Yet, several more of such strains may be expected since *A. intermedius* is the most common and widespread arionid in Belgium (MARQUET, 1982).

Arion (Carinarion) fasciatus s.l.

I use here the name *A. fasciatus* s.l. to denote a species complex coinciding with the subgenus *Carinarion*. It includes *A. fasciatus* (NILSSON, 1823) s.s., *A. circumscriptus* and *A. silvaticus*.

Generally, *A. fasciatus* s.l. has been reckoned amongst the most enigmatic arionids in Europe. Indeed, the three involved species are morphologically and anatomically highly similar and the lack of clear cut characters distinguishing them, has made it necessary to search for additional criteria. Therefore, CHICHESTER (1967) and BACKELJAU et al. (1987) performed electrophoretic analyses of albumen gland proteins of *Carinarion* spp. and defined in this way species specific profiles. Yet, even though these data support the specific rank of the three forms, parallel electrophoretic analyses of enzymes in American populations showed that the species actually consist of single genetic strains (McCRACKEN & SELANDER, 1980; SELANDER & OCHMAN, 1983). This indicates that *Carinarion* spp. have an uniparental breeding system. In that case, however, the biological species concept may be no longer applicable. Therefore, BACKELJAU (1987b) and BACKELJAU et al. (1987) suggested to treat *A. fasciatus* s.l. as an agamospecies complex, even though these authors also

assumed that *Carinarion* spp. may have a mixed breeding system, in which, however, uniparental reproduction would dominate. Yet, the problem is more complicated, since recently I found that in continental Europe, each of the three species contains not one, but several genetic strains (BACKELJAU & VAN ROMPAEY, 1988), of which at least 14 occur in Belgium (two strains of *A. circumscriptus* and 12 strains of *A. silvaticus*; *A. fasciatus* s.s. has hitherto not been recorded in Belgium). Obviously, these results may have far reaching systematic and ecogenetic consequences, which will be discussed in detail in a forthcoming paper.

Conclusive remarks

The most recent informations on the distribution of *Arion* spp. in Belgium have been provided by DE WILDE et al. (1986) and RISCH & BACKELJAU (1989). Yet, the present account demonstrates that these data are still far from complete. In fact, only the distributions of *A. hortensis* s.s. and *A. distinctus* are fairly well-known, whereas for all other species the distributional data need to be revised with respect to possible subdivisions into cryptic species and/or genetic strains. Obviously, the same applies to the ecological data. Finally, it should be pointed out that the variety of breeding systems apparently prevalent in *Arion*, provides a most interesting opportunity to investigate some tentative evolutionary and ecogenetic hypotheses such as for example the controversy about sympatric speciation and the evolutionary power of uniparental breeding systems.

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References cited

- ADAM, W., 1960. Faune de Belgique. Mollusques. I. Mollusques terrestres et dulcicoles. Uitgave van het Patriomonium van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel, 402 pp.
- BACKELJAU, T., 1981. Biometrie, ecologie, ethologie en systematiek van het *Arion hortensis* complex in België. Licentiaatsverhandeling, Universitaire Instelling Antwerpen, 78 pp.
- BACKELJAU, T., 1985a. Estimation of genic similarity within and between *Arion hortensis* s.l. and *A. intermedius* by means of isoelectric focused esterase patterns in hepatopancreas homogenates (Mollusca, Pulmonata: Arionidae). *Zeitschrift für zoologische Systematik und Evolutionsforschung* 23: 38-49.
- BACKELJAU, T., 1985b. A preliminary account of species specific protein patterns in albumen gland extracts of *Arion hortensis* s.l. (Pulmonata, Arionidae). *Basteria* 49: 11-17.
- BACKELJAU, T., 1986. Note on the original description of *Arion intermedius* NORMAND. *Gloria Maris* 25: 209-210.

- BACKELJAU, T., 1987a. Electrophoretic distinction between *Arion hortensis*, *A. distinctus* and *A. owenii* (Mollusca: Pulmonata). *Zoologischer Anzeiger* 219: 33-39.
- BACKELJAU, T., 1987b. Enzyme analyses of European *Carinarion* species (Mollusca, Pulmonata). *Annales de la Société Royale Zoologique de Belgique* 117: 253-254.
- BACKELJAU, T., 1988. The systematics and distribution of *Arion owenii* (Mollusca, Pulmonata). *Annales de la Société Royale Zoologique de Belgique* 118: 238.
- BACKELJAU, T., 1989. The original diagnoses of *Arion simrothi* KÜNKEL and *A. magnus* TORRES MINGUEZ (Mollusca, Pulmonata). *Annales de la Société Royale Zoologique de Belgique* 119: 199-211.
- BACKELJAU, T. & DE WINTER, A.J., 1987. An electrophoretic characterisation of three paratypes of *Arion fagophilus* DE WINTER, 1986, with notes on the subgeneric division of the genus *Arion* FÉRUSAC, 1819 (Mollusca, Pulmonata). *Zeitschrift für zoologische Systematik und Evolutionsforschung* 25: 169-180.
- BACKELJAU, T. & MARQUET, R., 1985. An advantageous use of multivariate statistics in a biometrical study on the *Arion hortensis* complex (Pulmonata: Arionidae) in Belgium. *Malacological Review* 18: 52-72.
- BACKELJAU, T. & VAN BEECK, M., 1986. Epiphallus anatomy in the *Arion hortensis* species aggregate (Mollusca, Pulmonata). *Zoologica Scripta* 15: 61-68.
- BACKELJAU, T. & VAN ROMPAEY, J., 1988. Genetic strains and breeding systems in three European *Carinarion* species (Mollusca, Pulmonata). Abstract book XVIth International Congress of Genetics, Toronto, 20-27 August 1988, *Genome* 30, Supplement 1: 356.
- BACKELJAU, T., AHMADYAR, S.Z., SELENS, M., ROMPAEY, J. & VERHEYEN, W., 1987. Comparative electrophoretic analyses of three European *Carinarion* species (Mollusca, Pulmonata: Arionidae). *Zoologica Scripta* 16: 209-222.
- BACKELJAU, T., DAVIES, S.M. & DE BRUYN, L., 1988. An albumen gland protein polymorphism in the terrestrial slug *Arion owenii*. *Biochemical Systematics and Ecology* 16: 425-429.
- BEESON, G.E., 1960. Chromosome numbers of slugs. *Nature* 186: 257-258.
- BOATO, A., BODON, M. & GIUSTI, F., 1983. On a new slug from the Northern Apennines (Pulmonata: Arionidae). *Archiv für Molluskenkunde* 114: 35-44.
- BURCH, J.B., 1965. Chromosome numbers and systematics in Euthyneuran snails. Proceedings of the First European Malacological Congress (1962), pp. 215-241.
- CHICHESTER, L.F., 1967. The zoogeography, ecology and taxonomy of arionid and limacid slugs introduced into northeastern North America. Unpublished Ph. D. Thesis, University of Connecticut, 234 pp.
- CHICHESTER, L.F. & GETZ, L.L., 1973. The terrestrial slugs of northeastern North America. *Sterkiana* 51: 11-42.
- COLLINGE, W.E., 1897. On some European slugs of the genus *Arion*. *Proceedings of the Zoological Society, London*, 3: 439-450.
- DAVIES, S.M., 1977. The *Arion hortensis* complex with notes on *A. intermedius* NORMAND (Pulmonata: Arionidae). *Journal of Conchology* 29: 173-187.
- DAVIES, S.M., 1979. Segregates of the *Arion hortensis* complex (Pulmonata: Arionidae), with the description of a new species, *Arion owenii*. *Journal of Conchology* 30: 123-127.
- DAVIES, S.M., 1987. *Arion flagellus* COLLINGE and *A. lusitanicus* MABILLE in the British Isles: a morphological, biological and taxonomic investigation. *Journal of Conchology* 32: 339-354.
- DE WILDE, J.J., 1983. Notes on the *Arion hortensis* complex in Belgium (Mollusca, Pulmonata: Arionidae). *Annales de la Société Royale Zoologique de Belgique* 113: 87-96.
- DE WILDE, J.J., 1986. Further notes on the species of the *Arion hortensis* complex in Belgium (Mollusca, Pulmonata: Arionidae). *Annales de la Société Royale Zoologique de Belgique* 116: 71-74.
- DE WILDE, J.J., MARQUET, R. & VAN GOETHEM, J.L., 1986. Voorlopige atlas van de landslakken van België. Uitgave van het Patrimonium van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel, 285 pp.
- DE WINTER, A.J., 1984. The *Arion hortensis* complex (Pulmonata: Arionidae): designation of types, descriptions, and distributional patterns, with special reference to the Netherlands. *Zoologische Mededelingen, Leiden*, 59: 1-17.
- FOLTZ, D.W., OCHMAN, H., JONES, J.S., EVANGELISTI, S.M. & SELANDER, R.K., 1982. Genetic population structure and breeding systems in arionid slugs (Mollusca, Pulmonata). *Biological Journal of the Linnean Society* 17: 225-241.
- FORCART, L., 1965. Rezente Land- und Süßwassermollusken der suditalienischen Landschaften Apulien, Basilicata und Calabrien. *Verhandlungen der Naturforschenden Gesellschaft, Basel*, 76: 59-184.
- GITTENBERGER, E., BACKHUYS, W. & RIPKEN, T.E.J., 1984. De landslakken van Nederland (2nd ed.). Uitgave van de Koninklijke Nederlandse Natuurhistorische Vereniging, No. 34, 184 pp.
- HESSE, P., 1926. Die Nacktschnecken der palaearktischen Region. *Abhandlungen des Archiv für Molluskenkunde* 2: 1-152.
- MARQUET, R., 1982. Studie over de verspreiding en de ecologie van de Belgische landmollusken. Doctoraatsverhandeling, Universitaire Instelling Antwerpen, 571 pp.
- MCCRACKEN, G.F. & SELANDER, R.K., 1980. Self-fertilization and monogenic strains in natural populations of terrestrial slugs. *Proceedings of the national Academy of Sciences of the U.S.A.* 77: 684-688.
- NORMAND, N.A.J., 1852. Description de six limaces nouvelles observées aux environs de Valenciennes. Valenciennes, 8 pp.
- QUICK, H.E., 1960. British slugs (Pulmonata; Testacellidae, Arionidae, Limacidae). *Bulletin of the British Museum of Natural History (Zoology)* 6: 103-226.
- RISCH, P., 1987. Bijdrage tot de systematiek van enkele soorten van het genus *Arion* FÉRUSAC (Mollusca: Pulmonata). Licentiaatsverhandeling, Universitaire Instelling Antwerpen, 51 pp.
- RISCH, P. & BACKELJAU, T., 1989. On the occurrence of *Arion lusitanicus* MABILLE, 1868 in Belgium (Mollusca: Pulmonata). *Annales de la Société Royale Zoologique de Belgique* 119: 25-38.

SELANDER, R.K. & OCHMAN, H., 1983. The genetic structure of populations as illustrated by molluscs. In: RATAZZI, M.C., SCANDALIOS, J.C. & WHITT, G.S. (Editors). Isozymes: Current topics in biological and medical Research. Vol. 10. Genetics and Evolution. Alan R. Liss, Inc. New York, pp. 93-123.

VAN GOETHEM, J.L., 1984. Lijst van de recente niet-mariene mollusken van België. *Studiedocumenten van het Koninklijk Belgisch Instituut voor Natuurwetenschappen* 16: 1-35.

VAN GOETHEM, J.L., 1987. Nieuwe naamlijst met aantekeningen van de recente niet-mariene weekdieren van België. *Studiedocumenten van het Koninklijk Belgisch Instituut voor Natuurwetenschappen* 44 : 1-65.

WALDÉN, H.W., 1976. A nomenclatural list of the land Mollusca of the British Isles. *Journal of Conchology* 29: 21-25.

ZEISSLER, H., 1981. Mollusken aus einem Hangwäldchen rechts der Kieler Bucht und einige Bemerkungen zu *Arion owenii* DAVIES, 1979. *Malakologische Abhandlungen, Dresden*, 7: 137-141.

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