ZOOLOGISCHE MEDEDELINGEN

UITGEGEVEN DOOR HET

RIJKSMUSEUM VAN NATUURLIJKE HISTORIE TE LEIDEN
(MINISTERIE VAN WELZIJN, VOLKSGEZONDHEID EN CULTUUR)

Deel 58 no. 22 31 december 1984 ISSN 0024-0672

ANATOMICAL EVIDENCE FOR THE OCCURRENCE OF *LYMNAEA (GALBA) PALUSTRIS* (O.F. MÜLLER, 1774) AND *L. (GALBA) CORVUS* (GMELIN, 1778) (GASTROPODA: LYMNAEIDAE) IN THE NETHERLANDS

by

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Velde, G. van der & C. M. van Kessel: Anatomical evidence for the occurrence of *Lymnaea (Galba) palustris* (O. F. Müller, 1774) and *L. (Galba) corsus* (Gmelin, 1778) (Gastropoda: Lymnaeidae) in The Netherlands.

Zool. Med. Leiden 58 (22), 31-xii-1984: 341-352, figs. 1-5, tables 1-3. — ISSN 0024-0672.

Key words: Mollusca; Gastropoda; Lymnaeidae; *Lymnaea (Galba) palustris*, *L. (Galba) corvus*; anatomy; The Netherlands.

A study was made on the *Lymnaea (Galba) palustris* complex in The Netherlands. Investigations on the genitalia proved that in The Netherlands two species are present, viz. *L. palustris* (O. F. Müller, 1774) and *L. corvus* (Gmelin, 1778), which can not in all cases be distinguished by shell characters. Genitalia were prepared, drawn and several measurements were carried out to investigate the variation within the two species. It appeared that most characters show a partial or total overlap.

Some characters appeared to separate the two species absolutely. One of these is very useful for a quick distinction of both species, viz. the situation of the truncus receptaculi with respect to the oviductus, which character is already visible after a general dissection of the mantle. Other reliable characters are the length of the vas deferens and the length ratio phallotheca proximalis/ phallotheca distalis.

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INTRODUCTION

The *Lymnaea (Galba) palustris* species complex has a holarctic distribution

(Hubendick, 1951). According to investigations in Poland (Jakiewicz, 1959) and in Czechoslovakia (Hudec & Brabenec, 1966), the complex in Europe consists of three species, viz. *L. corvus* (Gmelin, 1778), *L. turricula* (Held, 1836) sensu Jackiewicz (1959) and *L. occulta* (Jackiewicz, 1959).

The type specimens of *L. palustris* (O. F. Müller, 1774) are not known. Falkner made clear, however, that *L. turricula* is a younger synonym of *L. palustris*, so that the name *L. turricula* has to be replaced by *L. palustris* (O. F. Müller, 1774) (Butot, 1983; Falkner, 1984).

The three species can be distinguished mainly by genital characters. According to Jackiewicz (1959) and Hudec & Brabenec (1966), the anatomical differences between *L. corvus, L. palustris* and *L. occulta* appear in the ratio of the length of the phallotheca proximalis and phalloteca distalis, the shape of the truncus receptaculi and oviductus and the ratio of the size of the corpus pyriformis and glandula nidamentalis.

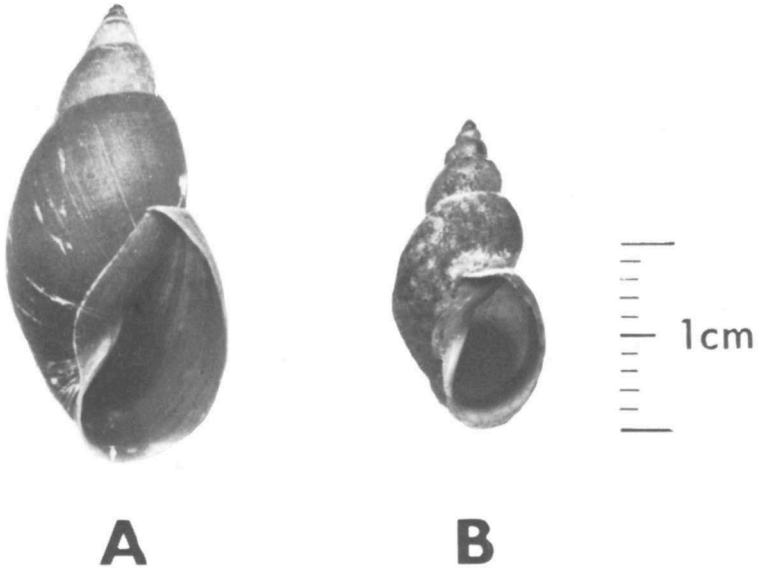


Fig. 1. Shell of *Lymnaea corvus* (Gmelin, 1778) (loc. Nijmegen) (A) and of *L. palustris* (O.F. Müller, 1774) (loc. Oosterhout) (B); for the genitalia of these specimens, see figs. 4 and 5.

According to these authors, the phallotheca proximalis in *L. corvus* is at least twice as long as the phallotheca distalis; in *L. palustris* the phallotheca proximalis is shorter than the phallotheca distalis, i.e. 1/2 - 1/3 the length of the latter; in *L. occulta* both are of about the same length, mostly with a somewhat shorter phallotheca distalis. In *L. corvus* the truncus receptaculi is rela-

tively wide and over about a third of its total length it is clearly swollen, whereas in *L. palustris* it is a very narrow tract equal in width over its whole length; in *L. occulta* it resembles that of *L. palustris*, but is clearly widened from the base till about half of its length. The oviductus of *L. corvus* is swollen, egg-shaped and extends beyond the outlet of the truncus receptaculi, while it is elongated and slender-cylindrical in *L. palustris*, short-cylindrical in *L. occulta*. In *L. corvus* the corpus pyriformis is globular and of about the same size as the glandula nidamentalis; in *L. palustris* it is globular but somewhat larger than the glandula nidamentalis, while it is large, wide, cylindrically elongated and several times larger than the small, globular glandula nidamentalis in *L. occulta*.

Willmann & Pieper (1978) roughly indicate the distribution of these species in Europe, which seems, however, partly based on doubtful data in the literature derived mainly from identifications by shell characters. Therefore anatomical investigations in more areas than Poland and Czechoslovakia are necessary to confirm the distribution data presented by Willmann & Pieper (1978).

The present paper deals with anatomical investigations on the *L. palustris* complex in The Netherlands. A second paper will deal with the shell characters of the species investigated. In the past these species were sometimes reported from The Netherlands as varieties of *L. palustris* based on very doubtful and vague shell features (Dorsman & De Wilde, 1929; Van Benthem Jutting, 1933; Janssen, 1975).

MATERIAL AND METHODS

The snails were obtained by collecting in several localities by the authors, while also older, preseved material was studied.

Material studied:

L. palustris:

Visvliet (Gr.), polder ditch, 6-VII-1969, 1 specimen, leg. R. Hengst; Terschelling (Fr.), polder ditch, 18-VII-1977, 1 specimen, leg. J. C. Huybregts; Nieuwe Bildtzijl-Blija (Fr.), polder ditch, 28-VIII-1979, 1 specimen, leg. G. Heijnen & L. Hogenkamp; Blija-Nes (Fr.), polder ditch, 28-VIII-1979, 2 specimens, 29-VIII-1979, 1 specimen, leg. G. Heijnen & L. Hogenkamp; Eemspolder-Gaarbindeweer (Gr.), polder ditch, 5-IX-1979, 2 specimens, leg. G. Heijnen & L. Hogenkamp; Den Haag (Z.H.), polder ditch, 8-IV-1969, 2 specimens, 9-V-1969, 1 specimen, leg. R. Hengst; Oosterhout (Gld.), polder ditch, 17-V-1982, 2 specimens, leg. C. M. van Kessel & G. van der Velde; Nijmegen (Gld.), small pond, 25-V-1982, 2 specimens, leg. C. M. van Kessel & G. van der Velde.

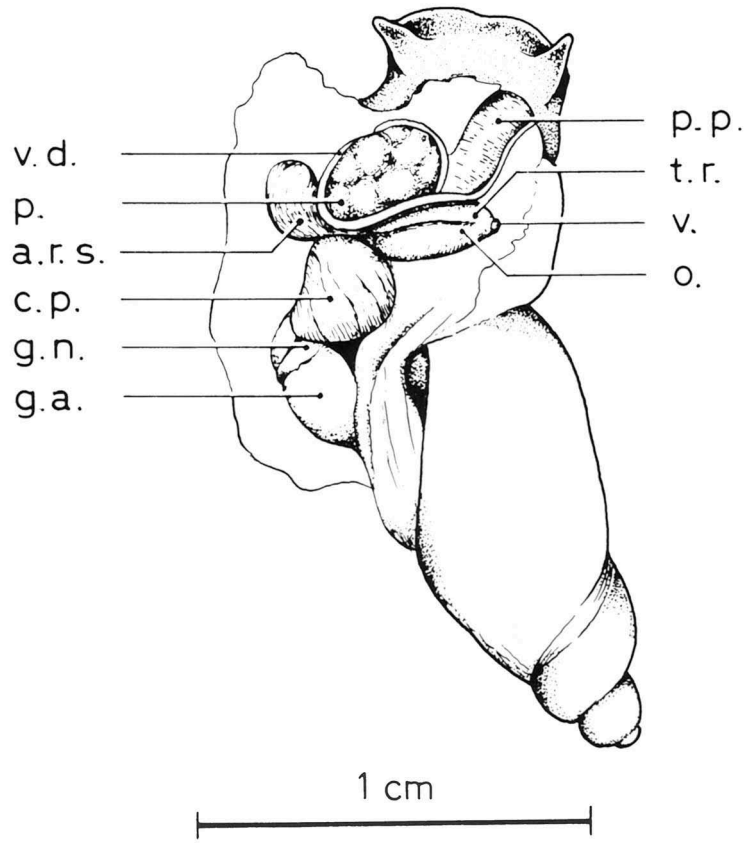


Fig. 2. *Lymnaea corvus* (Gmelin, 1778), general dissection to show positions of the genital organs. Abbreviations: v.d. = vas deferens, p. = prostata, a.r.s. = ampulla receptaculi seminis, c.p. = corpus pyriformis, g.n. = glandula nidamentalis, g.a. = glandula albuminalis, p.p. = phallotheca proximalis, v. = vagina, t.r. = truncus receptaculi, o. = oviductus.

L. corvus:

Twello (Ov.), ditch, 10-VII-1969, 6 specimens, leg. R. Hengst; Nijmegen (Gld.), shallow pond near Oude Waal, 24-IV-1978, 1 specimen, 17-V-1978. 1 specimen, 5-VI-1978, 1 specimen, 20-VI-1978, 3 specimens, 31-VII-1978, 1 specimen, 31-VII-1982, 1 specimen, leg. C. M. van Kessel & G. van der Velde; Nieuwkuyk (N. Br.), polder ditch, 9-VIII-1982, 1 specimen, leg. G. van der Velde.

studied material was deposited in the collection of the Rijksmuseum van Natuurlijke Historie (RMNH), Leiden.

The living snails were put into a jar with some water so that the snails were able to creep and could easily be killed with hot water. After that the animals

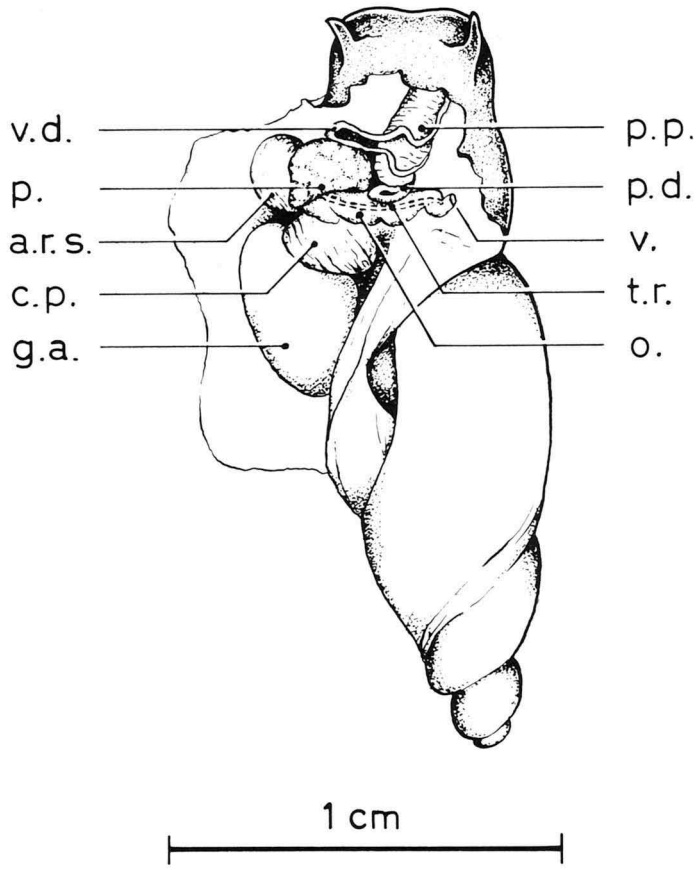


Fig. 3. *Lymnaea palustris* (O. F. Müller, 1774), general dissection to show positions of the genital organs. Abbreviations as in fig. 2.

were preserved in 70% alcohol. The advantage of killing with hot water is that the animals remain stretched and can be removed very easily from their shells. Animals fixed immediately in 70% alcohol retract into their shells and, as their muscles contract, preparation of their genitalia is difficult.

To study the genital features, the killed snails were removed from their shells with a pair of pincers. Then the mantle was dissected so that the normal position of the genital tracts could be studied (figs. 2, 3). After that the genitalia were prepared separately from the body and various parts of them were drawn and measured under a binocular. Of some of the genitalia separate preparations were made with the aid of dissection needles on a cork. These genitalia were transferred into alcohol 96%, then hardened and cleared up in xylol during five minutes and at last embedded in Canada balsem.

RESULTS

Two species appeared to be present in The Netherlands, viz. *L. (G.) palustris* and *L. (G.) corvus*. The results of the investigations are given in figs. 1-5 and tables 1-3.

Fig. 1 shows the shell of *L. corvus* and *L. palustris*; figs. 4 and 5 show drawings of genital preparations from the same specimens.

By dissecting the mantle the natural position of the genital tracts could be studied (figs. 2, 3). From such dissection it became clear that both species can be distinguished immediately, as in *L. corvus* the broad truncus receptaculi is always clearly visible in this way. In *L. palustris* the same tract is narrow and situated behind the oviductus, and thus not visible in this way.

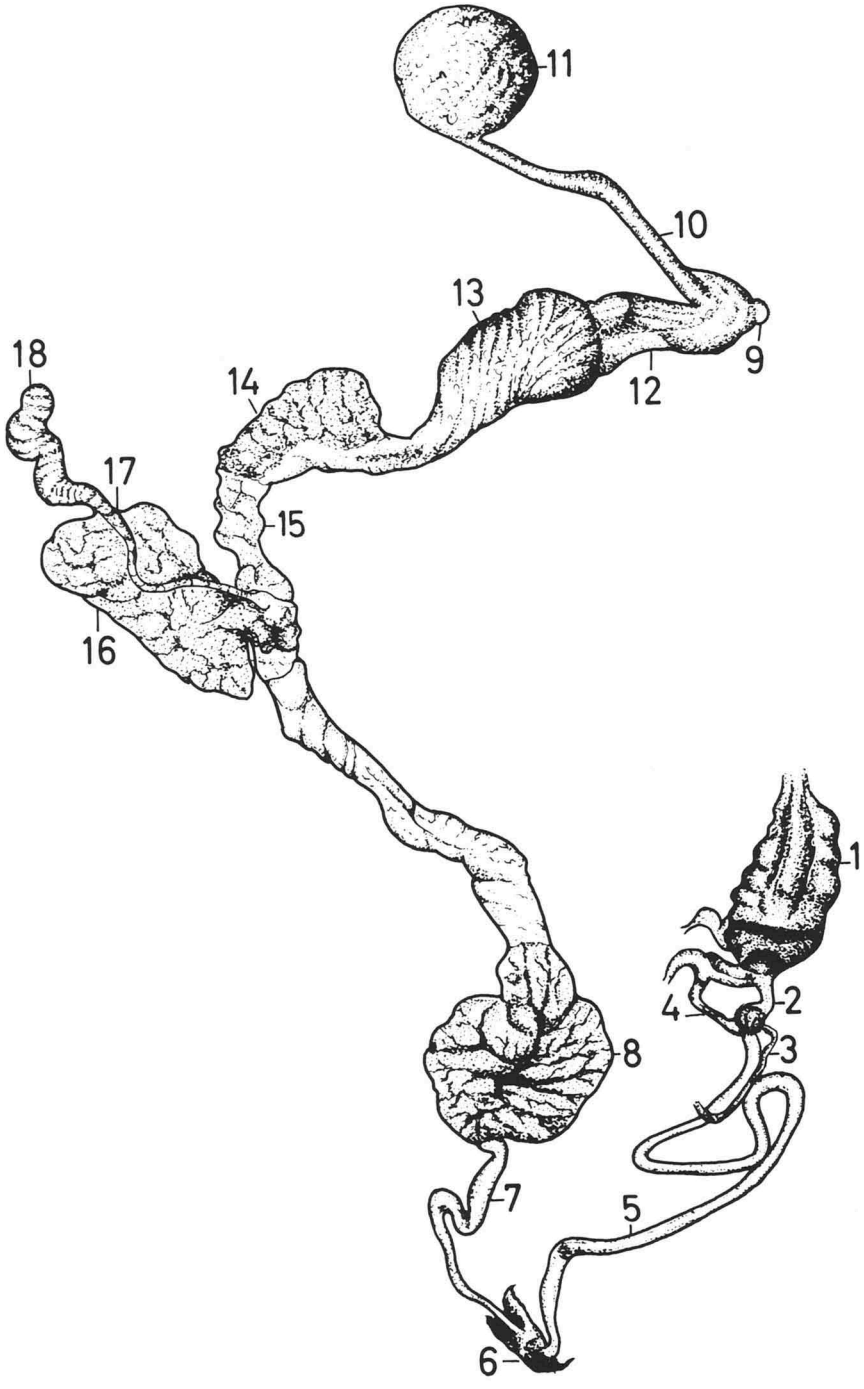
Measurements of length and width of the various genital organs studied are presented in table 1 to elucidate whether the genital organs of the two species differ in these characters. It appears that the length of the vas deferens (see figs. 4 and 5, no. 5-7) of both species shows no overlap. The length and width of all other organs studied show a distinct overlap or are completely within each other's ranges. The length/width ratios of the measured organs presented in table 2 show an overlap so that separation by these characters is not always possible.

In table 3 the length ratios of the various organs of the two species are given. It appears from this table that the ratios 1/2 (phallotheca proximalis/phallotheca distalis), 2/5-7 (phallotheca distalis/vas deferens), 2/11 (phallotheca distalis/ampulla receptaculi seminis), 2/9-12 (phallotheca distalis/vagina-oviductus), 2/16 (phallotheca distalis/glandula albuminalis), 2/17-18 (phallotheca distalis/ductus hermaphroditica-glandula hermaphroditica), 2/8-15 (phallotheca distalis/prostata-uterus), 5-7/9-12 (vas deferens/vagina-oviductus) separate the two species virtually completely, while all other ratios show the same range or a distinct overlap.

DISCUSSION AND CONCLUSIONS

Investigations of material from The Netherlands showed that two species are present here, viz. *L. palustris* and *L. corvus*.

Fig. 4. Genital tract of *Lymnaea corvus* (Gmelin, 1778). 1. phallotheca proximalis (praeputium), 2. phallotheca distalis, 3. nervus penis, 4. musculus retractor, 5. vas deferens proximalis, 6. passage through body wall, 7. vas deferens distalis, 8. prostata, 9. vagina, 10. truncus receptaculi, 11. ampulla receptaculi seminis, 12. oviductus, 13. corpus pyriformis, 14. glandula nidamentalis, 15. uterus, 16. glandula albuminalis, 17. ductus hermaphroditicus, 18, glandula hermaphroditica.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Organ		*Lymnaea (Galba) palustris*					*Lymnaea (Galba) corvus*				
		minimum	maximum	mean	S.D.	N	minimum	maximum	mean	S.D.	N
		mm	mm	mm	mm		mm	mm	mm	mm	
1	length	2.0	4.5	3.05	0.65	15	2.4	4.6	3.79	0.75	15
1	width	0.9	1.7	1.18	0.22	15	0.9	1.9	1.53	0.27	15
2	length	2.2	5.3	3.74	0.88	15	1.0	2.6	1.55	0.44	15
2	width	0.2	0.5	0.34	0.09	15	0.2	0.5	0.31	0.07	15
5-7	length	10.2	16.3	12.71	1.92	12	17.6	38.8	23.03	5.62	13
5-7	width	0.1	0.2	0.16	0.03	11	0.2	0.4	0.23	0.06	13
8	length	1.7	3.6	2.76	0.52	15	2.5	4.4	3.40	0.48	15
8	width	0.9	2.3	1.49	0.42	15	1.8	3.2	2.45	0.43	15
11	length	1.2	2.4	1.78	0.35	15	1.6	4.3	2.60	0.74	14
11	width	0.8	2.0	1.39	0.33	15	1.4	3.8	2.46	0.76	14
9-12	length	2.6	4.4	3.55	0.55	14	2.1	4.5	3.25	0.57	15
9-12	width	0.5	1.1	0.74	0.22	14	0.8	1.9	1.14	0.27	14
16	length	1.9	5.5	3.65	1.00	15	3.0	6.4	4.45	1.00	15
16	width	0.8	3.2	1.87	0.65	15	1.2	4.0	2.02	0.78	15
17-18	length	3.6	8.5	5.91	1.36	11	2.4	12.5	7.03	2.83	13
17-18	width	0.5	1.4	0.88	0.30	11	0.3	1.0	0.58	0.20	13
8-15	length	3.0	4.7	3.71	0.56	9	2.4	8.0	4.79	1.57	15
8-15	width	0.3	0.7	0.48	0.12	9	0.4	1.2	0.79	0.28	15

Table 1. Minimum, maximum and mean lenghts and widths of the various genital organs of *Lymnaea palustris* (O. F. Müller, 1774) and *L. corvus* (Gmelin, 1778); for explanation of organ numbers, see figs. 4 and 5. S.D. = standard deviation, N = number of observations.

Two genital characters mentioned by Jackiewicz (1959) and Hudec & Brabenec (1966) appeared to be useful for separating the two species in The Netherlands, viz. the length ratio phalloteca proximalis / phallotheca distalis and the shape of the truncus receptaculi. The difference, however, between *L. palustris* and *L. corvus* with respect to the corpus pyriformis and glandula nidamentalis could not be confirmed in the Dutch material.

During our investigations some other reliable differences in the genitalia between *L. palustris* and *L. corvus* were found. The species can be separated by the following characters:

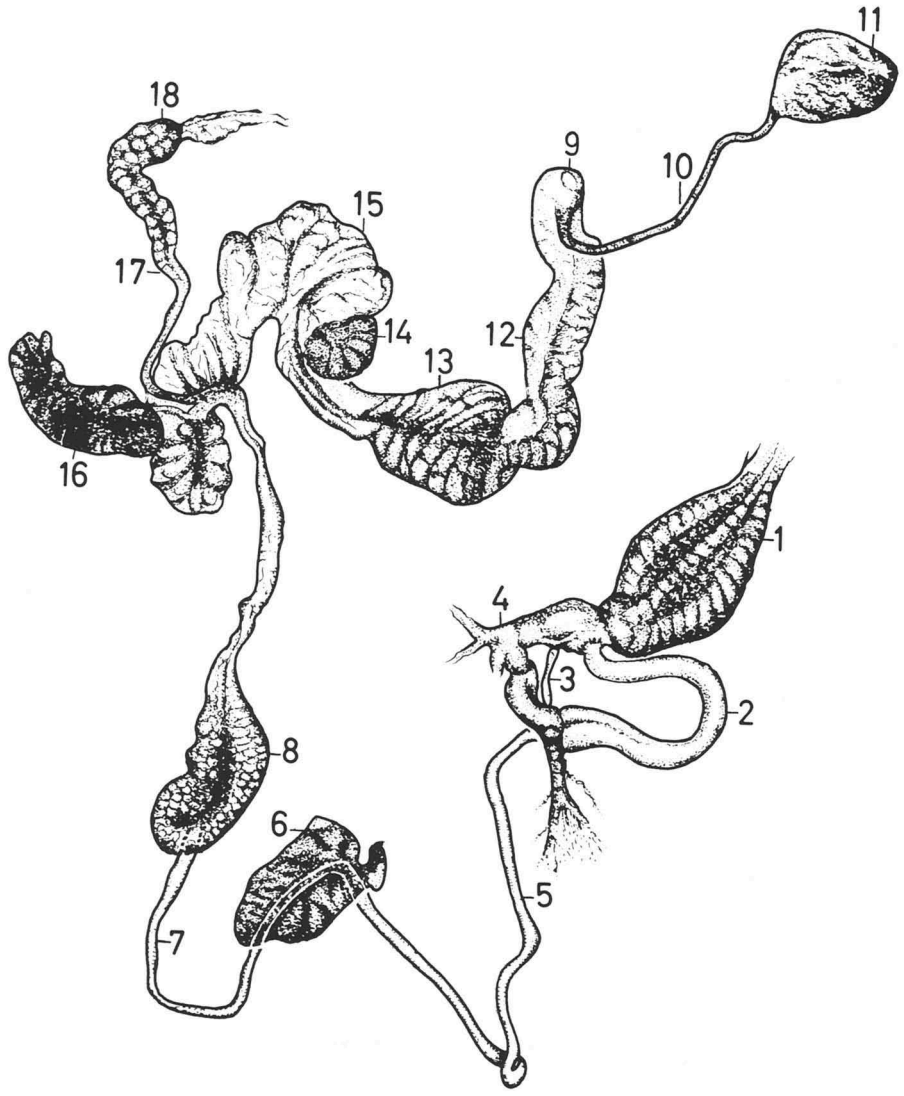

Fig. 5. Genital tract of *Lymnaea palustris* (O.F. Müller, 1774). For explanation of the numbers, see fig. 4.

L. palustris	*L. corvus*
General dissection of the mantle: the narrow truncus receptaculi invisible, hidden under the oviductus.	General dissection of the mantle: the broad truncus receptaculi always visible, running besides the oviductus.
Length vas deferens: 10.2-16.3 mm	Length vas deferens: 17.6-38.8 mm
Ratio length phallotheca proximalis/ length phallotheca distalis: 0.49-1.00	Ratio length phallotheca proximalis/ length phallotheca distalis: 1.77-3.44

The first-mentioned character can be used to identify large samples in a relatively quick way.

The fact that most anatomical characters give no complete separation must be interpreted as a confirmation of the very close relationship between the two species.

ACKNOWLEDGEMENTS

The authors are very much indebted to Prof. Dr. C. den Hartog, Prof. Dr. J. T. Wiebes and Dr. E. Gittenberger for critical remarks and to Mr. R. Hengst, Mr. G. Heijnen, Mrs. L. Hogenkamp and Mr. J. C. Huybregts for providing material. Special thanks are also due to Mr. J. R. van der Zee and Mr. Th. C. M. Oor for making the drawings.

	length/width ratios									
	Lymnaea (Galba) palustris					*Lymnaea (Galba) corvus*				
Organ	minimum	maximum	mean	S.D.	N	minimum	maximum	mean	S.D.	N
1	1.59	3.75	2.63	0.58	15	1.79	3.38	2.50	0.47	15
2	4.40	22.50	11.82	4.52	15	3.67	8.67	5.12	1.31	15
5-7	52.50	108.67	81.14	17.72	11	85.00	128.50	101.14	14.51	13
8	1.42	2.78	1.93	0.41	15	1.09	1.89	1.41	0.23	15
11	1.00	1.73	1.32	0.24	15	0.71	1.43	1.09	0.21	14
9-12	3.36	7.20	5.13	1.37	14	2.33	4.00	2.88	0.55	14
16	1.47	2.45	2.01	0.31	15	1.60	3.33	2.35	0.54	15
17-18	3.93	9.50	7.12	1.89	11	6.00	22.33	12.38	4.40	13
8-15	5.29	15.67	8.28	2.98	9	2.73	11.25	6.79	2.96	15

Table 2. Minimum, maximum and mean length/width ratios of the various genital organs of *Lymnaea palustris* (O. F. Müller, 1774) and *L. corvus* (Gmelin, 1778); for explanation of organ numbers, see figs. 4 and 5. S.D. = standard deviation, N = number of observations.

	Lymnaea (Galba) palustris					*Lymnaea (Galba) corvus*				
Ratio	minimum	maximum	mean	S.D.	N	minimum	maximum	mean	S.D.	N
1/2	0.49	1.00	0.83	0.15	15	1.77	3.42	2.53	0.48	15
1/5-7	0.16	0.38	0.26	0.06	12	0.12	0.24	0.17	0.03	13
1/8	0.59	1.88	1.14	0.31	15	0.74	1.41	1.12	0.19	15
1/11	1.00	2.40	1.74	0.33	15	0.69	2.28	1.52	0.42	14
1/9-12	0.54	1.36	0.87	0.20	14	0.74	1.47	1.18	0.20	15
1/16	0.42	1.42	0.89	0.26	15	0.57	1.37	0.87	0.19	15
1/17-18	0.39	0.78	0.55	0.12	11	0.37	1.29	0.61	0.27	13
1/8-15	0.62	0.97	0.79	0.11	9	0.44	1.29	0.86	0.29	15
2/5-7	0.22	0.45	0.31	0.06	12	0.05	0.10	0.07	0.01	13
2/8	0.65	2.14	1.40	0.39	15	0.32	0.74	0.45	0.11	15
2/11	1.10	3.46	2.15	0.55	15	0.31	0.94	0.60	0.16	14
2/9-12	0.59	1.73	1.06	0.31	14	0.32	0.58	0.47	0.09	15
2/16	0.46	2.00	1.11	0.44	15	0.25	0.44	0.35	0.07	15
2/17-18	0.44	1.25	0.70	0.22	11	0.14	0.44	0.24	0.09	13
2/8-15	0.71	1.35	0.95	0.19	9	0.16	0.63	0.35	0.14	15
5-7/8	3.52	6.38	4.81	0.92	12	5.14	11.09	6.91	1.67	13
5-7/11	5.25	10.31	7.35	1.85	12	5.06	13.44	9.26	2.30	13
5-7/9-12	3.11	5.15	3.64	0.65	11	5.35	8.64	7.24	1.14	13
5-7/16	2.49	5.52	3.62	1.01	12	4.14	8.57	5.44	1.23	13
5-7/17-18	1.73	3.72	2.22	0.60	11	2.55	7.33	3.67	1.37	13
5-7/8-15	2.48	3.98	3.33	0.50	8	3.91	8.53	5.36	1.34	13
8/11	0.85	2.40	1.60	0.38	15	0.81	2.19	1.37	0.33	14
8/9-12	0.47	0.97	0.78	0.13	14	0.78	1.47	1.07	0.17	15
8/16	0.55	1.32	0.80	0.22	15	0.50	1.00	0.78	0.12	15
8/17-18	0.31	0.63	0.47	0.09	11	0.28	1.04	0.56	0.24	13
8/8-15	0.52	1.10	0.75	0.17	9	0.44	1.46	0.78	0.30	15
8/11	0.85	2.40	1.60	0.38	15	0.81	2.19	1.37	0.33	14
11/9-12	0.33	0.70	0.51	0.11	14	0.55	1.06	0.81	0.17	14
11/16	0.27	0.84	0.52	0.17	15	0.40	0.82	0.60	0.13	14
11/17-18	0.20	0.50	0.32	0.09	11	0.20	0.79	0.42	0.20	13
11/8-15	0.39	0.65	0.49	0.10	9	0.34	0.95	0.58	0.18	14
9-12/16	0.70	1.79	1.06	0.36	14	0.57	1.20	0.75	0.16	15
9-12/17-18	0.50	0.72	0.61	0.07	10	0.30	0.88	0.52	0.20	13
9-12/8-15	0.64	1.20	0.99	0.20	8	0.40	1.21	0.73	0.23	15
16/17-18	0.36	1.08	0.63	0.21	11	0.35	1.42	0.71	0.31	13
16/8-15	0.68	1.55	0.98	0.25	9	0.58	2.00	1.01	0.38	15
17-18/8-15	0.90	2.03	1.64	0.34	8	0.60	3.23	1.66	0.76	13

Table 3. Minimum, maximum and mean length ratios of the various genital organs measured in *Lymnaea palustris* (O.F. Müller, 1774) and *L. corvus* (Gmelin, 1778); for the explanation of the organ numbers, see figs. 4 and 5. S.D. = standard deviation, N = number of observations.

SAMENVATTING

Een studie van de genitalia van slakken behorende tot het *Lymnaea (Galba) palustris*-complex wees uit dat er in Nederland tenminste twee soorten hiervan voorkomen, namelijk *L. palustris* (O. F. Müller, 1774) en *L. corvus* (Gmelin, 1778), die op grond van hun huisjes niet in alle gevallen zijn te onderscheiden. De genitalia van een aantal exemplaren werden uitgeprepareerd, getekend en verschillende onderdelen hiervan werden opgemeten teneinde de variatie binnen beide soorten te onderzoeken. Het bleek dat de meeste kenmerken van beide soorten geheel of gedeeltelijk overlappen.

Slechts enkele kenmerken bleken absoluut scheidend. Eén van deze kenmerken is zeer bruikbaar voor een snel onderscheid tussen beide soorten, namelijk de ligging van de truncus receptaculi ten opzichte van de oviductus, die zichtbaar is wanneer de mantel is opgensneden (figs. 2, 3). Twee andere goed bruikbare kenmerken zijn de lengte van de vas deferens en de verhouding tussen de lengte van de phallotheca proximalis en phallotheca distalis.

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